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ABSTRACT

This learner manual for rescuers covers the current techniques or practices required in the rescue service. The second of 10 modules contains 5 chapters: (1) patient care and handling techniques; (2) rescue carries and drags; (3) emergency vehicle operations; (4) self-contained breathing apparatus; and (5) protective clothing. Key points, an introduction, and conclusion accompany substantive material in each chapter. (NLA)

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RESCUE MANUAL

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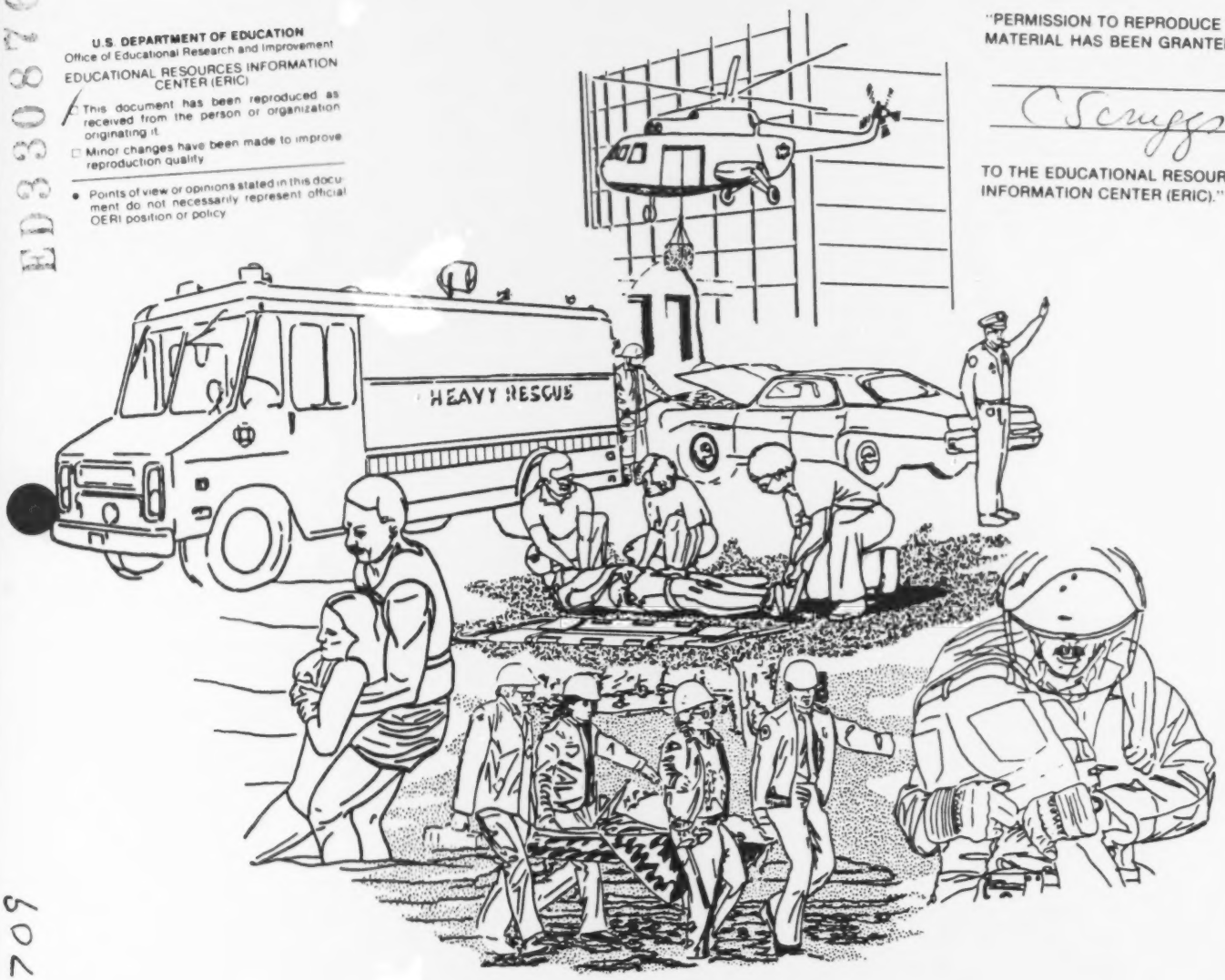

CE 057 709

MODULE 2

Patient Care and Handling Techniques
Rescue Carries and Drags
Emergency Vehicle Operation
Self-Contained Breathing Apparatus
Protective Clothing

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2

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THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210

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Rescue operations may subject both rescuer and victim to the possibility of injury or death. Rescuers must understand the nature and effect of each rescue technique, and practice techniques regularly, using this text to enhance their learning. The materials and information presented here are intended only as a learning aid, and are no substitute for training. Expert opinions, recommendations, and guidelines change as research and experience refine procedures. This text includes the most up-to-date information from rescuers working in the field.

Specialized procedures require demonstration and training by subject-matter experts. It is not likely that a rescuer will become proficient in all rescue operations. Most rescuers develop proficiency in only a few areas but may be familiar with several others.

This text suggests procedures and explains how to do them. The techniques given are guidelines only. Each department should incorporate its own procedures and address local needs.

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RESCUE MANUAL

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FOREWORD

The intent of this manual for rescuers is to provide the latest instructional content and serve as an up-to-date, comprehensive source of information covering the current techniques or practices required in the rescue service. To help in this endeavor, an instructor's manual has been developed to be used in conjunction with this learner's manual. The manual has been produced in a series of modules to facilitate future revisions more rapidly and cost effectively.

The instructor's manual follows the key points identified in the text. Chapters have been included in the text which exceed those printed in any other resource. These include managing and operating the emergency vehicle, rope rescue techniques, industrial rescue, farm accident rescue, and various water emergency procedures, among others.

That the rescue profession is a dangerous and challenging career is a recognized fact. It is our hope that this text will help the rescuer meet the challenges of the rescue service in a safe and professional manner.

Tom Hindes
Director
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PREFACE

The Ohio State University Instructional Materials Laboratory has played a major role in the training of public safety personnel through the development of text materials for many years. Due to the advances in the rescue techniques, it became apparent that the existing text was obsolete. Upon the advice of many knowlegeable people in the rescue service, the Instructional Materials Laboratory initiated the development of a new text that would be easily updated, and address the needs of the rescuer. To this end, an editorial review board representing a broad spectrum of individuals in the various phases of the research profession was convened to determine what topics this text should address. The culmination of this effort is the Rescue Manual. It is hoped that this text will be useful to not only the new rescuer but will serve as a reference source for the experienced rescuer.

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MODULE 2

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PATIENT CARE AND HANDLING TECHNIQUES

KEY POINTS

- **Providing proper patient care and handling**
- **Maintaining a patient's airway**
- **Maintaining a patient's circulation and treating for shock**
- **Performing a cervical spine immobilization**

INTRODUCTION

At the center of any rescue operation is human life. The actions of rescuers are critical factors in the victim's recovery. Rescue personnel must have a basic understanding of patient care, handling techniques, and equipment used since the injuries sustained in an accident vary, and usually require specific procedures.

Rescue personnel should be trained to the level of a basic EMT, and preferably to an advanced level. In a long, painful extrication, a patient may need medication administered to relieve pain and suffering. There may be times when no emergency medical personnel are involved in rescue operations, so at the very least, rescuers should know basic patient care and handling techniques, and the equipment used to reduce the risk of further injury.

All rescue personnel should be trained in cardiopulmonary resuscitation (CPR) in accordance with the American Heart Association (AHA) standards. It is not uncommon for victims to need CPR. Many public safety service agencies have specifically defined local protocol that must be followed when providing prehospital care. Rescuers must remain aware of the current local requirements.

PROVIDING PATIENT CARE

Airway

First priority in any patient-care situation is maintaining sufficient airway and breathing. All rescue personnel should focus first on opening and maintaining the patient's air passage, and providing breathing assistance and oxygen as needed.

In rescue operations, always suspect neck and back injuries, since patients have often sustained a blunt-force type of injury. All rescue personnel must be proficient in the jaw-thrust maneuver (see Figure 1) to open the airway. This procedure is used to keep the head and neck in a neutral position to avoid further problems if there is a cervical-spine injury. Perform this maneuver by placing the hands alongside the head with the fingers at the angle of the jaw and moving the jaw forward gently to clear the airway of the tongue, the most common obstruction. Further information on the jaw-thrust maneuver is available from the American Heart Association, or available from The Ohio State University, Instructional Materials Laboratory's, Emergency Victim Care Learner's Modules.

Figure 1. Jaw-thrust Maneuver

In addition to the tongue blocking the airway, there may be some type of liquid obstruction such as blood, mucus, or vomitus. The best immediate procedure is to turn the patient as a unit to the side, allowing the fluid to flow from the mouth (see Figure 2). If it is not possible to turn the patient, use suctioning equipment to clear the airway (see Figure 3).

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Figure 2. Turning Victim on Side to Clear Airway

Figure 3. Using Suction Equipment to Clear Airway

When a patient is unconscious, use an oral or nasal pharyngeal airway (see Figure 4) to maintain the airway. If the entrapment is prolonged, advanced life support personnel should be summoned to the scene to maintain the airway through endotracheal intubation or surgical cricothyrotomy. Maintaining an airway is essential to life; therefore rescuers must focus patient care priorities on creating and maintaining an airway.

Once the airway has been sustained, provide supplemental oxygen. If the patient is breathing below normal limits (see Figure 5), or not breathing at all, ventilate through a positive pressure device (see Figure 6) or a bag valve mask (see Figure 7).

Oxygen is essential to life. Brain cells die after four to six minutes without it. If the patient is breathing on his or her own and within normal limits, supplemental oxygen may be provided once the injuries are under control. A high level of oxygen in the blood of an injured patient lessens the severity of the injury. Also, the patient will go into shock if a sufficient level of oxygen is not present in the blood.

Figure 4. Nasal Pharyngeal Airway

AGE	RESPIRATION
Newborn	28-32
1 year	28-30
2 years	24-28
3 years	24-26
4 years	24-26
5 years	22-26
6 years	20-24
7 years	20-24
8 years	20-22
9 years	18-22
10 years	18-20
11 years	18-20
12 years	18-20
13 years	18-22
14 years	18-20
15 years	16-18
16 years	16-18
17 years	16-18
18 years	15-20

Figure 5. Range of Respirations

If necessary, oxygen can be administered through a non-rebreather mask (see Figure 8) at six to ten liters per minute (lpm). Adjust the oxygen flow according to the patient's condition. When oxygen is being administered, an emergency medical technician (EMT) or paramedic must be with the patient to monitor his or her condition.

Figure 6. Positive Pressure Device

Figure 7. Bag Valve Mask

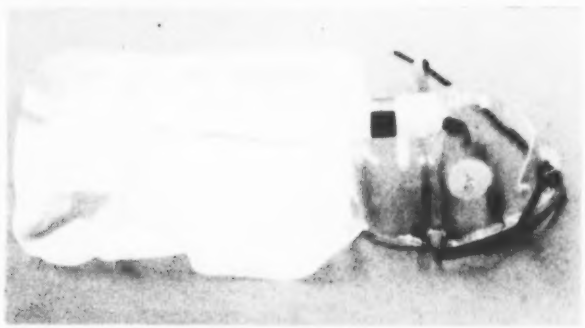

Figure 8. Nonrebreather Mask

Circulation and Treatment for Shock

Maintaining circulation and treating shock are the next priorities for the rescuer. First, determine if the patient has a pulse and is circulating blood through the system.

If there is no pulse, start CPR immediately. As previously stated, it is necessary for all rescue personnel to be certified in CPR and remain current with new standards and techniques. The patient should be placed in a position so chest compressions can be performed in accordance with American Heart Association guidelines. If the patient cannot be placed in such a position, it is unlikely the patient can be saved.

Once the rescuer has determined that the patient has a pulse, and that the circulatory system is working, any bleeding must be stopped immediately to keep the circulatory system functioning.

To control bleeding and stop the loss of blood, find the source of the bleeding and apply pressure directly to that source. There are other methods of bleeding control, but direct pressure is the most effective and the most immediate. Once bleeding is under control, determine the level of shock present and start intervention measures.

Shock is sometimes referred to as a quiet killer; it literally deprives the tissues and organs of blood and, most importantly, oxygen. It is essential that all rescuers recognize the signs and symptoms of shock and provide basic and advanced care for the patient. Signs and symptoms are: a decreased level of consciousness; a weak, rapid pulse; cool, clammy skin; and a drop in blood pressure.

All signs and symptoms of shock are easy to recognize through observation and examination, and do not require special equipment for assessment. Assessment techniques are shown in Figure 9.

If one or all of these signs and symptoms are present, begin treatment for shock. The basic treatment for shock is to:

1. Provide oxygen. Shock deprives tissues and organs of oxygen.
2. Keep the patient warm. Warmth is essential to body functions; the cooler the body becomes the more oxygen it requires.
3. Maintain the body position. The head should be positioned lower than the heart. An adequate blood supply must be maintained at all times.

In addition to the basic prehospital care, advanced procedures must also be started by an EMT and paramedic in any prolonged extrication. In most rescue operations, the patient's condition involves the loss of fluids. The sooner fluids can be replaced, the better the chance is for complete recovery of the patient. Medical anti-shock trousers (MAST) and intravenous (IV) therapy should be initiated if necessary.

Signs and Symptoms	Assessment
Low level of consciousness	Talk to the patient. How does he or she respond? Is the patient awake and alert, or sleepy and unable to communicate? The more stimulus it takes to arouse the patient, the lower the level of consciousness; the lower the level of consciousness, the more serious the patient's condition.
Weak, rapid pulse	Feel for the pulse; the carotid artery is the best location for this check. If the pulse rate is over 100 and the pulse is barely obtainable, this patient is in a serious condition.
Pale, cool, clammy skin	Feel and look at the skin. If the patient looks pale and feels cold, it is likely there is an insufficient amount of blood in the patient's system to provide oxygenation.
Drop in blood pressure	Feel for pulse. Exact numbers are not needed at this point. Relative pressures are indicated if the following pulses are present: Radial pulse = approx. 90 systolic Femoral pulse = approx. 80 systolic Carotid pulse = approx. 70 systolic

Figure 9. Signs and Symptoms of Shock

Cervical Spine (C-spine) Immobilization

Once the life-threatening problems are managed, the patient must be immobilized for disentanglement and extrication procedures. Nearly every victim trapped in a vehicle experiences some type of blunt-force injury, often resulting in a cervical-spine injury.

Several types of equipment are available for (cervical-spine) immobilization. Each department should contact its local medical control advisor to determine which equipment is recommended for C-spine immobilization.

When performing C-spine immobilization, first place the head in alignment with the spine. Second, apply a rigid cervical collar device to maintain the head alignment (see Figure 10) in a neutral position. Third, apply a rigid support to keep the spine in line and to prevent moving the neck from right to left, and up and down. At least four prehospital care providers should be available to accomplish C-spine immobilization.

Figure 10. Application of Rigid Cervical Device

The procedures illustrated in Figures 11 to 31 represent only a few of the techniques with which rescue personnel should become familiar. For more information, see the Emergency Victim Care Learner's Modules available from the Instructional Materials Laboratory, The Ohio State University, Columbus, Ohio 43210.

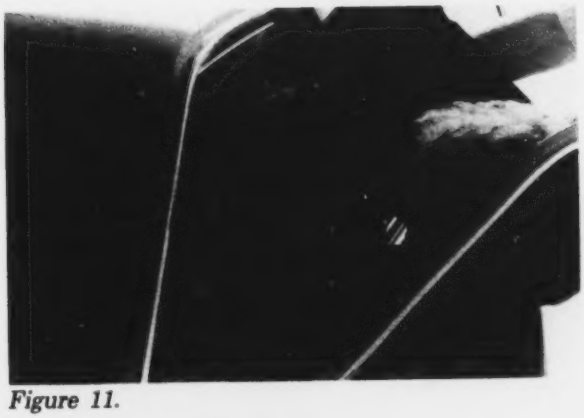

Figure 11.

Figure 12.

Figure 13.

Figure 14.

Figure 15.

Figures 11, 12, 13, 14, 15. KED Application

Figure 16.

Figure 17.

Figure 18.

Figure 19.

Figures 16, 17, 18, 19. Backboard - Lying Position

Figure 20.

Figure 21.

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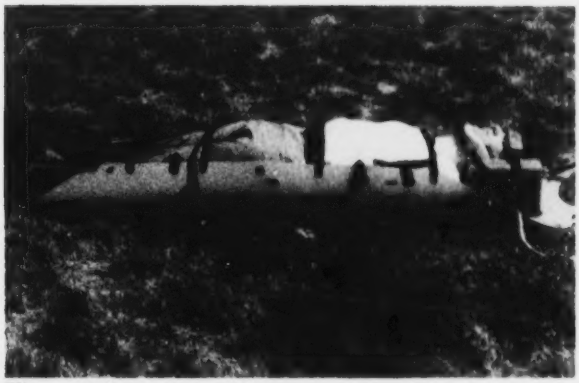
Figure 22.

Figure 23.



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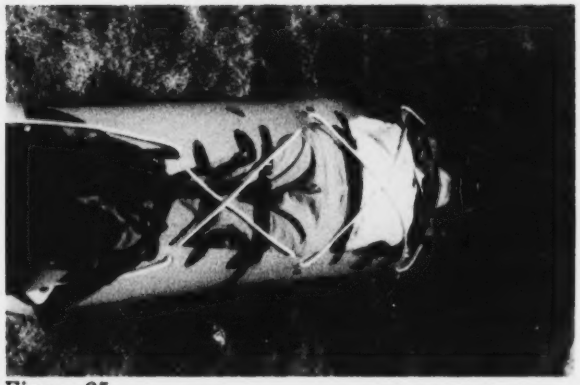
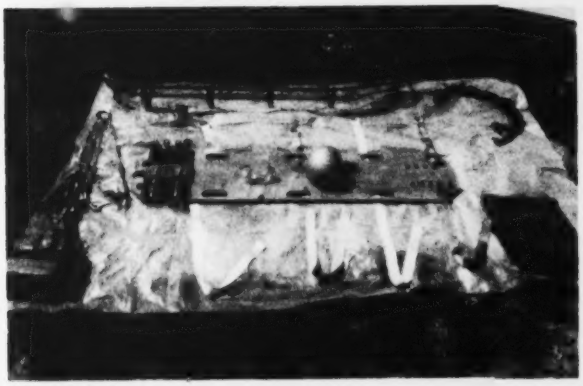


Figure 25.

Figure 26.

Figures 22, 23, 24, 25, 26. SKED Stretcher



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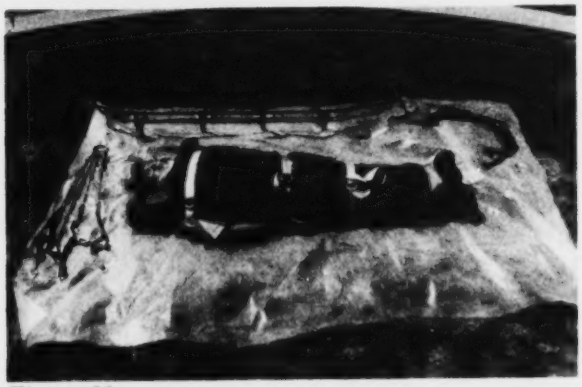

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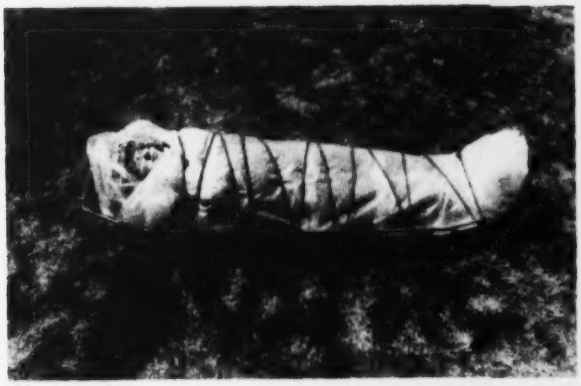

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Figure 30.

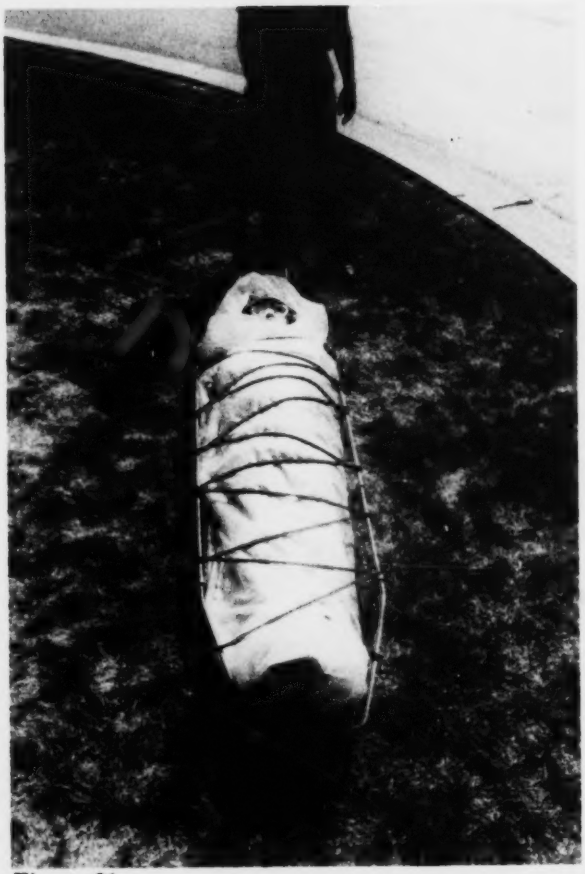

Figure 31.

Figures 27, 28, 29, 30, 31. Rescue Basket

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RESCUE CARRIES AND DRAGS

KEY POINTS

- Importance of rescue carries and drags
- How and when to use the various rescue carries
- How and when to use the various rescue drags
- How to transport a victim down a ladder
- How to care for victims after the rescue

INTRODUCTION

An important part of rescue work is the successful removal of an injured or unconscious victim from a situation where a stretcher or backboard cannot be used. An accident victim or rescuer subjected to intense heat, heavy smoke, gases, or falling materials often becomes injured or unconscious. Rescuers must be able to quickly carry or drag a victim to safety in any emergency situation with minimum risk to the victim and the rescuers.

RESCUE CARRIES

Various rescue carries are used to move a victim. The rescuer needs to select the carry that is most appropriate for the situation. Rescuers need to know the following carries.

Chair Carry

The chair carry is used where there are sharp turns or steep stairways. Before using the chair, the rescuers should test it to make sure it is solid and will support a victim. Once the victim is placed on the chair, the first rescuer at the rear of the chair tilts it backward to enable a second rescuer in front of the chair to get into position to carry (see Figure 32).

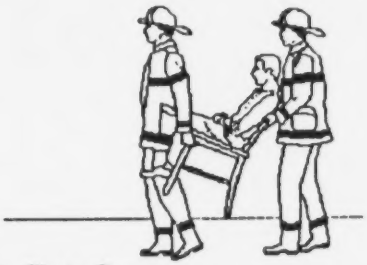

Figure 32. Chair Carry

Fire Fighter's Carry

Balance and coordination are very important to get a victim on the rescuer's shoulders for this carry. Using the fire fighter's carry, a rescuer can raise any victim that can be carried. The rescuer must place the victim in a supine position, knees up, and feet against the buttocks (see Figure 33-A). Next, the rescuer grasps the victim's wrists with palms (rescuer's) down (see Figure 33-B).

Figure 33-A. Fire Fighter's Carry

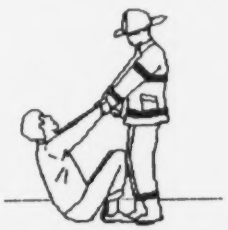

Figure 33-B. Fire Fighter's Carry

Figure 33-C. Fire Fighter's Carry

The rescuer places the feet and legs against the victim's feet and legs as shown in Figure 33-C. Then the rescuer leans back and pulls the victim forward and upward at the same time. The victim will fall across the rescuer's shoulders so the rescuer can proceed with the carry. (see Figure 33-D).

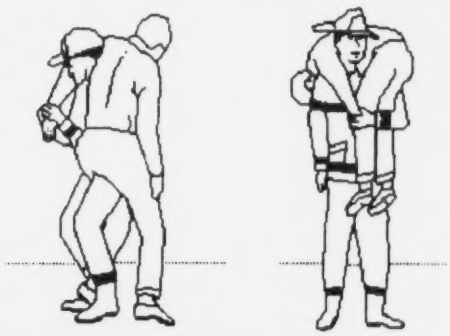

Figure 33-D. Fire Fighter's Carry

Carrying in Arms

To carry an unconscious victim in the arms, the rescuer lifts the victim to an erect position as described in the fire fighter's carry. The rescuer supports the victim with one arm about the body and kneels on one knee allowing the victim to rest on the rescuer's other knee. The rescuer then passes his or her other arm under the victim's thighs, and rolls the victim into the hollow of the elbows and rises (see Figure 34). The rescuer can then proceed with the carry.

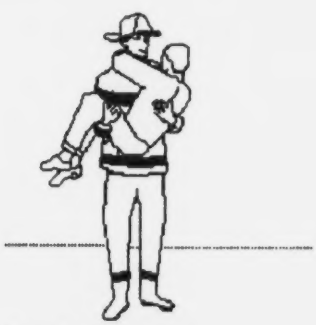

Figure 34. Carrying in Arms

Carrying Astride Back

Carrying a victim astride the back is a comfortable one-person method for transport, but is limited to carrying a conscious victim who can partially stand. After assisting the victim to a standing position, the rescuer should stand in front of and away from the victim, turn his or her back to the victim, take the victim's arms over the shoulders and cross them. Then the rescuer bends forward until the victim rests on the rescuer's back. The rescuer grasps each thigh and raises the victim up on the back. The rescuer passes his or her forearms under the victim's legs, and takes a wrist in either hand. In case the victim becomes unconscious, the grasp on the wrist keeps the victim on the rescuer's back (see Figure 35).

Figure 35. Carrying Astride Back

Pack-strap Carry

The pack-strap carry is a one-person carry for a conscious victim. For a conscious victim, the rescuer loads the victim exactly as described in the first step for the astride-back carry (see Figure 36-A). When the victim is on the back, the rescuer grasps the victim's crossed arms at the wrists, bends forward, thrusts the victim onto the back, and proceeds with the carry. Note that the rescuer has one hand free.

Figure 3

Figure 36-A. Pack-strap Carry (Conscious Victim)

Front Piggyback Carry

The front piggyback carry is a one-person carry that is a good method for carrying a conscious victim. To get the victim into position, the rescuer faces the victim and places his or her hands under the victim's armpits. The victim jumps and puts his or her legs around the rescuer's midriff just above the hips. By wrapping the victim's arms around the rescuer's neck, the rescuer has both hands free to climb or descend a ladder, or open a door. If trouble develops while descending a ladder, the rescuer can pin the victim against the ladder and call for assistance (see Figure 37).

Figure 37. Front Piggyback Carry

Two-person Seat Carry

The two-person seat carry shown in Figures 38-A and 38-B is another means of carrying an injured or unconscious person. Two rescuers make a seatrest and a backrest with their arms. Figure 38-A shows how the arms are arranged. The rescuers should kneel, one on each side of the victim's hips, and raise the victim to a sitting position, steadying the victim by placing an arm around the victim's neck.

Each rescuer then slips the other arm under the victim's thighs. Each rescuer should clasp the wrist of the other rescuer. Both rescuers rise in unison slowly, lifting the victim from the ground. When erect, the rescuers can adjust their upper arms to form a comfortable backrest and secure the victim (see Figure 38-B). The victim, if conscious, can assist by grasping the rescuers around the neck.

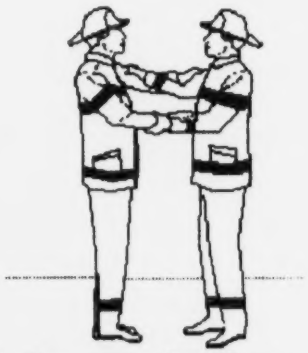

Figure 38-A. Two-person Seat Carry

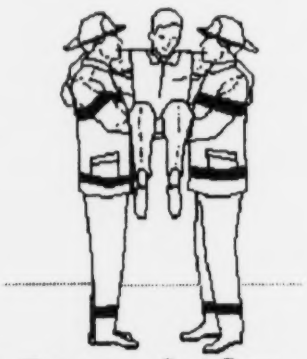

Figure 38-B. Two-person Seat Carry

Carrying by the Extremities

Carrying a victim by the extremities is a good carrying method, but should not be used if the victim has a fracture. Lay the victim straight on his or her back with the feet apart. One rescuer stands between the victim's legs, and a second rescuer stands at the victim's head. The rescuers should be facing each other. The rescuer at the victim's feet turns his or her hands palms down, grasps the victim's wrists, and pulls the victim into a sitting position. The person at the victim's head assists in raising the victim to a sitting position by lifting the victim's shoulders (see Figure 39-A).

The rescuer at the head position kneels on one knee and supports the victim's back with the opposite knee and leg. Then, the rescuer at the head of the victim extends his or her hands, with palm sides down, under the victim's armpits from back to front. The rescuer at the victim's feet places the victim's wrists in the extended hands of the other rescuer. The rescuer at the victim's head grasps the victim's wrist. (see Figure 39-B).

Next the rescuer at the victim's feet stands between the victims legs facing away from the victim, and kneels on one knee. Then the rescuer should pass his or her hands under the victim's knees from the outside. The rescuer at the head position assumes a baseball catcher's position, keeping his or her back vertical. At the order "Rise," by either of the rescuers, both rescuers should rise, straightening their legs. (see Figure 39-C). They can then proceed with the carry.

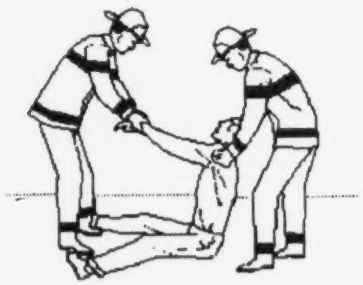

Figure 39-A. Preparing to Carry by the Extremities

Figure 39-B. Preparing to Lift

Figure 39-C. Carrying by the Extremities

Three-person Carry

The three-person carry is used to carry a badly injured person (see Figures 40-A, 40-B, and 40-C). Three rescuers align themselves on one side of the victim, at the shoulders, hips, and knees, when the leader gives the command, "Prepare to lift." each rescuer kneels on the knee nearest the victim's feet. Without further orders, the rescuers pass their hands and forearms under the victim as shown in Figure 40-A.

Figure 40-A. Three-person Carry

The rescuer at the victim's shoulders places his or her hands under the victim's neck and back; the rescuer at the victim's hips places his or her hands under the victim's pelvis and hips; and the rescuer at the victim's knees places his or her hands under the victim's knees and ankles. At the command "Lift", the rescue team raises the victim and rests him or her on the rescuers' knees. The rescuers must not release the hands (see Figure 40-B).

Figure 40-B. Three-person Carry

At the command "Prepare to rise," the rescuers slowly turn the victim on the side toward them until the victim rests in the bend of their elbows. At the command "Rise," all three rescuers rise to a standing position and hold the victim against their chests, as shown in Figure 40-C. To move directly forward, the command "March" is given and all three rescuers step off on the left foot and continue until the command "Halt" is given. To move sideways, the command "Side step left" (or "...right") is given. The rescuers step off with the foot according to the command, bringing the other foot up to it in even, short steps. At the command of the leader, the victim can be lowered by reversing the operation. During practice, it is not necessary to give detailed com-

mands. The rescuers should be trained so they can move and act in unison with a minimum of commands.

Figure 40-C. Three-person Carry

RESCUE DRAGS

There are situations when a rescuer must drag, rather than carry, a victim. Rescuers must know the following procedures to drag a victim.

Clothes Drag

When a victim is too heavy to be carried, the rescuer can use the clothes drag shown in Figure 41 to get the victim to safety. To perform a clothes drag, the rescuer grasps the victim's collar and rests the victim's head on the rescuer's arm for protection. The rescuer then proceeds to drag the victim.

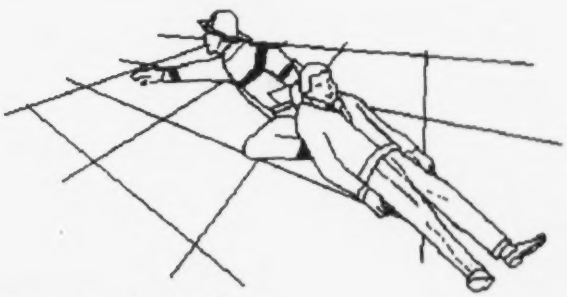

Figure 41. Clothes Drag

Fire Fighter's Drag

To perform a fire fighter's drag, the rescuer ties the victim's wrists together (in front) using a piece of clothing tied in a square knot. The rescuer straddles the victim, places head between the victim's arms, raises the victim's head and shoulders just off the floor, and then, by crawling, drags the victim to safety.

When descending a stairway using the fire fighter's drag, reverse the rescuer's position. The rescuer descends the stairs backwards. This prevents the victim's head from hitting the steps.

The Blanket Drag

The blanket drag can be used in place of the clothes drag to transport a nude victim. The rescuer places a blanket on the floor and rolls the victim onto the blanket. The victim can then be removed to safety as shown in Figure 42.

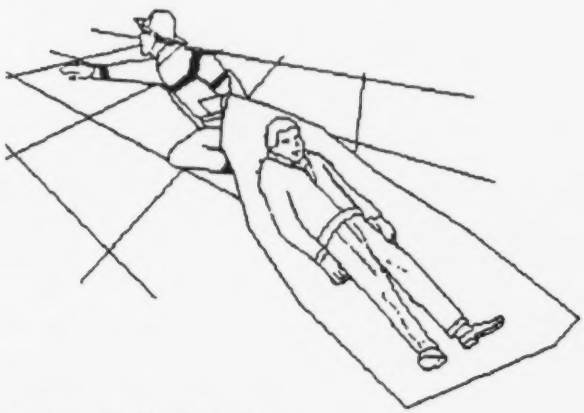

Figure 42. Blanket Drag

LADDER RESCUES

Sliding an Unconscious Victim Down a Ladder

To slide an unconscious victim down a ladder, the rescuer starts with a crotch-hold position. The rescuer works up the ladder until his or her arms are beneath the victim's armpits. He or she grasps the rungs of the ladder in front of the victim's face, while placing his or her knee is beneath the victim's crotch. The rescuer positions the victim's feet outside the beams and slowly slides the victim down the ladder (see Figure 43.) The primary rescuer should be backed by a second rescuer.

Figure 43. Sliding an Unconscious Victim Down a Ladder

Walking a Victim Down a Ladder

Walking a victim down a ladder as shown in Figure 44 is done with the rescuer taking a position directly behind and parallel to the victim, and one rung below the victim. The rescuer places his or her arms around the victim's body below the armpits and grasps a rung. He or she slowly descends the ladder one rung at a time. As a precautionary measure, the rescuer should keep one knee between the victim's legs to prevent him or her from sliding.

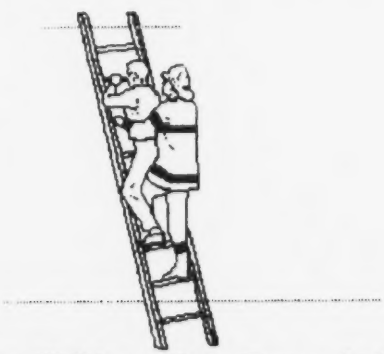

Figure 44. Walking a Victim Down a Ladder

Walking a Victim Down an Aerial Ladder

Walking a victim down an aerial ladder differs from the preceding method because the rescuer's knee is not placed between the legs of the victim. The rescuer's arms are placed around the victim's body below the armpits. The rescuer should grasp the rung directly below the rung the victim is grasping. The rescuer should then descend slowly down the ladder, one rung at a time. Figure 45 shows how to walk a victim down an aerial ladder.

Figure 45. Walking a Victim Down an Aerial Ladder

Sliding a Victim Down a Ladder Across Arms

To slide a victim down a ladder, the primary rescuer stands on the ladder just below the door, window, or roof where the victim is located and grasps the ladder with both hands on the underside of the beams. A second rescuer places the victim across the primary rescuer's arms as shown in Figure 46-A. The first rescuer then descends the ladder one step at a time with the victim's buttocks resting on each rung of the ladder during descent. The rescuer's hands slide along the underside of the beam. The primary rescuer on the ladder should be backed by the second rescuer (see Figure 46-B).

Figure 46-A. Placing the Victim Across the Rescuer's Arms

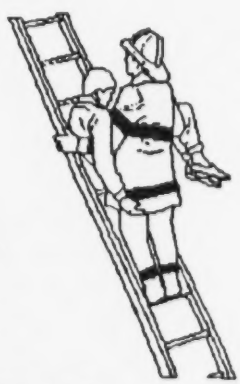

Figure 46-B. Sliding a Victim Down a Ladder Across Arms

CARE OF VICTIMS AFTER BEING RESCUED

Need for Special Care

Rescue is a difficult and dangerous operation even for the trained and experienced. Rescuers must exercise care to prevent untrained persons from exposure to unnecessary dangers. Rescuers must prevent persons who have escaped a burning building from reentering the structure to retrieve possessions left behind.

The duty of the rescuers does not end once victims are brought to safety. Infants, children, the sick, and the aged all need care and supervision after being rescued.

Care of an Infant

An infant, subjected to a sudden drop in temperature after being removed from a heated building, can contract pneumonia or some other illness. If possible, deliver a rescued infant to a competent person for proper care.

Care of Children

If left unattended, children can wander around a fire area and become injured. They even reenter a burning building seeking something left behind. Always place children in the custody of a competent person.

Care of the Sick

Victims rescued from a sick bed may suffer a relapse causing an illness to become worse. If the illness is not contagious, find temporary shelter for them in a neighboring home. If the victim has a contagious condition, make provisions as soon as possible to have the patient transported to a hospital. A heated garage can provide temporary shelter, but care must be given to the patient until moved to a hospital.

Care of the Aged

Not realizing the danger, aged people have lost their lives after being rescued to safety by reentering the building to retrieve personal possessions. If possible, bring cherished objects out with the person. Once rescued, place the person in the custody of a competent person.

SELF-CONTAINED BREATHING APPARATUS

KEY POINTS

- Types of self-contained breathing apparatuses
- Hazardous environments encountered in rescue work
- Types of poisonous gases and their properties
- Maintaining and operating the breathing apparatus
- Donning breathing apparatus while wearing protective clothing
- Cleaning and sanitizing the breathing apparatus for future use
- Inspecting and caring for the facepiece, exhalation valve, and breathing tube
- Inspecting, testing, and changing the air cylinders
- Emergency techniques using breathing apparatus to assist other rescuers, conserve air, and restrict use of by-pass valves

The objectives listed below should be followed by any person using a self-contained breathing apparatus. The user shall be able to:

- identify at least four hazardous respiratory environments encountered when fighting a fire
- demonstrate the use of all types of protective breathing apparatus in a dense smoke environment
- identify the physical requirements of the wearer, the limitations of the protective breathing apparatus, and the safety features of all types of protective breathing apparatus
- demonstrate donning breathing apparatus while wearing protective clothing
- demonstrate that the protective breathing apparatus is in a safe condition for immediate use
- identify the procedure for cleaning and sanitizing protective breathing apparatus for future use
- identify the procedure for daily inspection and maintenance of breathing apparatus
- given each type of breathing apparatus, demonstrate the correct procedure for recharging
- demonstrate the following emergency technqiues using breathing apparatus to:
  a) assist other rescuers
  b) conserve air
  c) restrict use of by-pass valves

INTRODUCTION

Although a self-contained breathing apparatus (SCBA) is one of many pieces of equipment carried on rescue apparatus today, it is, without a doubt one of the most important. In this modern age of chemicals, plastics, refrigerants, synthetic materials, and various compounds used in industrial processes, it is extremely important to protect the rescuers who often work in oxygen-deficient atmospheres containing poisonous and toxic gases. There have been occasions when rescuers who were not wearing their SCBAs have died while attempting to rescue people trapped or overcome in smoke or gaseous areas.

The stress encountered while wearing an SCBA demands that a rescuer must be in good physical condition. Many local employers have implemented physical fitness programs within their organization.

Definition

The self-contained breathing apparatus used by the rescue service today is a refinement of the oxygen masks used by the Army and the Air Force during World War II high-altitude flying. The SCBA is a mask attached to a pressurized bottle containing breathable air. It may be a pressure-demand system, a closed-circuit system using compressed or liquid oxygen, or a closed-circuit system that generates oxygen. The SCBA is worn at all times when there is insufficient oxygen to support life and in areas where toxic gases are likely to be present.

Self-contained Breathing Apparatus

Self-contained breathing apparatuses provide complete respiratory protection in any concentration of toxic gases under any condition of oxygen deficiency. The wearer's breathing is independent of the surrounding atmosphere since the wearer is breathing in a system in which no outside air is admitted, and the oxygen or air supply of the apparatus itself takes care of all respiratory requirements. SCBAs enable rescuers to work in places where they normally would not be able to live.

Self-contained breathing apparatuses are divided into three basic types: (1) pressure-demand, (2) closed-circuit using compressed or liquid oxygen, and (3) closed circuit that chemically generates oxygen. The pressure-demand type masks is the most commonly used SCBAs and is described below.

Pressure-Demand Breathing Apparatus. The pressure-demand breathing apparatus mask maintains a higher pressure on the inside of the facepiece than the atmospheric pressure on the outside. Therefore, a leak in the facepiece flows outside and not inside. Springs on the atmospheric side of the diaphragm and exhalation valve balance the system, so no outside air can enter the system. The spring pressure against the diaphragm in the regulator opens the admission valve enough to allow an air flow that maintains the positive pressure inside the facepiece. The exhalation valve has an equal spring to balance the pressure requirements of the regulator admission valve. These masks are donned and used like other self-contained breathing apparatuses.

APPROVAL OF RESPIRATORY PROTECTIVE EQUIPMENT

Respiratory protective devices are tested and approved by the National Institute for Occupational Safety and Health (NIOSH) and Mine Safety and Health Administration (MSHA) and further all masks must meet NFPA 1981 Standard on SCBA for fire fighters. Departments using masks with Bureau of Mines approval should check with the mask manufacturer to see if this equipment can be updated to receive NIOSH approval. Unapproved masks should not be used. NIOSH has federal control over the manufacturing specifications of breathing apparatus, which gives them the responsibility of approval, fitting, training, and maintaining the equipment.

IMPORTANCE OF SCBA TO RESCUE OPERATIONS

One of the fundamental rules of rescue is that no one without a self-contained breathing apparatus is allowed in an oxygen-deficient atmosphere. Providing for the life safety of the rescuers is a paramount responsibility of the officers in charge of a rescue. In addition to the duty of training rescuers in the use of respiratory equipment, the officers should see that the rescuers use this equipment whenever and wherever necessary.

In recent years, another hazard has been added to the problem of rescue: the use of nuclear energy in industrial, commercial, and educational structures. This problem has become more complicated by the presence and use of radioactive materials at many locations. The U.S. Atomic Energy Commission states that SCBAs should be worn from the time of arrival at a site where radiation hazards exist until the hazard no longer exists.

It would be impossible to list or discuss every hazardous gas. The most common gases rescuers encounter are shown in Figure 47. This chart indicates the properties, characteristics, effects, and treatments of these gases with which the rescuers should become familiar.

It is suggested that rescue personnel survey the community to determine any additional hazardous gases that could be encountered in industrial, mercantile, or commercial areas. Then, in cooperation with the chemists, engineers, or other responsible persons in charge of these operations, a supplementary chart of poisonous gases can be prepared and used for reference. This is an excellent method for gaining good relations with the people in the community. They will be pleased to cooperate, knowing that the rescue service is interested in the community's safety and welfare.

TYPES OF GASES

Rescuers encounter many different types of gases. The following information provides the physical and chemical characteristics of each gas.

Air

Air is a mixture of gases (primarily oxygen and nitrogen) with a small percentage of carbon dioxide. Oxygen, which is necessary to sustain life, comprises

POISONOUS GASES AND THEIR PROPERTIES

GAS	WHERE FOUND OR USED	WEIGHT COMPARED TO AIR	COLOR	ODOR	TASTE	WILL BURN SKIN	WILL BURN EYES	WILL BURN THROAT	ACTION AND EFFECT ON VICTIM	EXPLOSIVE OR FLAMMABLE	REMOVE FROM CAUSE AND TREAT FOR
Acetylene	Welding shops and factories	Lighter	No	Sweet	No	No	No	Yes	Slow or delayed	Yes	Shortness of breath or asphixia; shock
Ammonia	Large cooling plants	Lighter	No	Yes	Yes	Yes	Yes	Yes	Quick and delayed	Yes	Shortness of breath or asphyxia; shock; eyes; burns
Carbon Monoxide	Results of incomplete combustion	Lighter	No	Slightly garlic, usually not noticed	No	No	No	Yes	Quick	Yes	Keep victim inert; shortness of breath or asphyxia; shock
Chlorine	Purification plants, laundries	Heavier	Greenish-yellow	Pungent	Yes	Yes	Yes	Yes	Quick and delayed	No	Shortness of breath or asphyxia; shock; eyes; burns
Hydrogen Cyanide	Exterminating buildings	Lighter	No	Bitter Almond	Yes	No	No	No	Quick	Yes	Shortness of breath or asphyxia; shock
Hydrogen Sulphide	Cesspools	Heavier	No	Rotten eggs	Yes	No	Yes	Yes	Quick	Yes	Shortness of breath or asphyxia; shock; eyes
Methyl Chloride	Refrigeration	Heavier	No	Yes	No	No	No	No	Slow and delayed	Yes	Shortness of breath or asphyxia; shock
Natural Gas	Home and industrial use	Lighter	No	Yes	No	Yes	Yes	Yes	Quick	Yes	Shortness of breath or
LP Gases	Home and industrial use	Heavier	No	Yes	No	Yes	Yes	Yes	Quick	Yes	asphyxia; shock
Nitrous Oxide Fumes	Fires and electric welding	Heavier	Deep orange	Pungent	Yes	No	No	No	Slow and delayed	No	Shortness of breath or asphyxia; shock
Phosgene	Dry cleaners and fires	Heavier	No	New hay	No	No	Yes	Yes	Slow and delayed	No	Keep victim inert; shortness of breath or asphyxia; shock; eyes
Sulphur Dioxide	Bleaching and fumigating	Heavier	No	Bitter	Acid	No	Yes	Yes	Quick	No	Shortness of breath or asphyxia; shock

Figure 47. Poisonous Gases and Their Properties

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approximately 21% of the air. Nitrogen acts as a diluting agent for the very active oxygen and comprises about 79% of the air. Carbon dioxide is present in very small quantities (about .04%).

Under normal conditions, air contains some water vapor. In dealing with gases, the standard of comparison used is dry air, and the unit of measurement is specific gravity. The specific gravity of air equals 1.000. For example, if the specific gravity of carbon dioxide is 1.5, a given volume of carbon dioxide is 1.5 as heavy as the same volume of air at the same pressure and temperature. Therefore, carbon dioxide does not blend rapidly with air but settles to lower spaces. If the specific gravity of a gas is less than that of air, then the gas is lighter and rises to the upper parts of a building. Its rate of blending with air is slow. Gases having specific gravity near that of air blends rapidly with the air.

Oxygen

Oxygen is a nonflammable and nonpoisonous gas designated by the symbol 0_2 with a specific gravity of 1.1053. It is colorless, odorless, and tasteless, and does not conduct electric current. It is a poor conductor of heat, is slightly soluble in water, and does not burn. However it does support combustion; without oxygen there would be no fires. When the oxygen content of air falls below the normal amount (about 21%), a person breathes a little faster and deeper. If the oxygen content decreases to about 16%, a person may become dizzy, notice a buzzing in the ears, have an increased heart rate, or suffer from a headache. When the oxygen content falls below 15%, a person may become unconscious and death from suffocation may result. The greater the physical activity of a person where air is deficient of oxygen, the more quickly these symptoms appear.

Carbon Dioxide

Carbon dioxide, designated by the symbol CO_2 with a specific gravity of 1.5, is the product of combustion and is expelled by all animal life in exhalation. It is nonflammable, nonpoisonous, colorless, and odorless, and may have an acid taste if breathed in large quantities. Air containing about .04% carbon dioxide may cause a person to breathe deeper and faster. If the content increases to 10% or more, a person becomes unconscious. Death by suffocation may result from deficiency of oxygen in the air after several hours of exposure.

Carbon dioxide can be compressed to a liquid and is, used in liquid refrigerator units, soda fountains, and bottling works. CO_2 is much heavier than air and settles over a fire, thus excluding the oxygen. CO_2 extinguishers are used extensively and are very efficient.

Carbon Monoxide

Carbon monoxide, designated by the symbol CO, has a specific gravity of .967 and is a colorless, odorless, tasteless, flammable, and explosive gas. It has nearly the same density as air. The gas is a product of incomplete combustion. It is insoluble in water and burns with a blue flame. It contains only half as much oxygen as carbon dioxide. It can be caused to burn by combining with more oxygen through certain chemical processes. An oxide of manganese and copper called "hopcalite" is used to bring about oxidation of CO_2 in gas masks. This oxidation purifies the air for breathing.

Carbon monoxide is a very poisonous gas. The red corpuscles of the blood contain a substance called hemoglobin, which has 200 to 300 times the affinity for carbon monoxide as it has for oxygen. It combines in the lungs with oxygen and circulates throughout the body, giving oxygen to the tissues as needed.

When carbon monoxide is inhaled, it forms a stable compound with hemoglobin and destroys the oxygen-carrying power of the hemoglobin. If 60% to 70% of the hemoglobin is affected, a sufficient amount of oxygen is not carried to the brain and degenerative processes occur. The nerve centers that control breathing fail to respond. The first symptoms are a slight headache and discomfort, followed by a tendency to stagger, heart palpitations, confusion, nausea, and vomiting. If exposure continues, unconsciousness and death result. Where a large amount of CO is present in the air, the effect may be so sudden that a person will have little or no warning before lapsing into unconsciousness. Carbon monoxide is fatal when it reaches a proportion of 1/2 of 1% of the air, or even 1/5 of 1% if breathed for any length of time.

The danger of inhaling carbon monoxide gas is of great concern to rescue personnel. Carbon monoxide is undetectable by human senses and can be present in a dangerous quantity even when there is very little smoke. The density of the smoke is not indicative of the amount of carbon monoxide that may be present, even after the fire is extinguished. Due

to this fact, it is very important for rescuers to keep wearing their SCBAs even after the building has been ventilated. Special measuring devices have proven that residence fires are more likely to manufacture carbon monoxide than other fires.

The most common causes and sources of carbon monoxide are the incomplete combustion of burning fuel gases, detonation of explosives, explosion of methane and natural gases, and exhaust fumes from automobiles or instantaneous water heaters. Antidotes used in severe cases of carbon monoxide poisoning are transfusion of blood from a healthy person, injections of methylene blue plus heart stimulant, and a medication called carbogen.

Phosgene

Phosgene, designated by the symbol $COCL_2$, has a specific gravity of 1.432 and is a colorless, tasteless gas having a very disagreeable odor. It is formed by passing carbon monoxide and chlorine through hot charcoal. At a fire it may be produced when carbon tetrachloride from a fire extinguisher is sprayed on a hot object or when refrigerants, such as Freon, come into contact with a flame. It is a strong lung irritant, of which the full poisonous effect is not evident for several hours after exposure. Twenty-five parts of phosgene in a million parts of air is deadly. When phosgene comes in contact with water, it decomposes into hydrochloric acid. Since the lungs and bronchial tubes are always moist, phosgene forms hydrochloric acid in the lungs when inhaled.

Chlorine

Chlorine, designated by the symbol CL, has a specific gravity of 2.45 and is a greenish-yellow gas with a very unpleasant, suffocating odor. It is used extensively in water purification plants, paper mills, and swimming pools. Chlorine is readily detected in the air before it is present in dangerous quantities, because it causes irritation to the throat and lungs. One-half hour of exposure to even the quantity detectable by odor, or about four parts per million, is dangerous.

Carbon tetrachloride fluid produces chlorine when it comes in contact with hot metal. The physical discomfort of inhaling this gas is somewhat relieved by the inhalation of ammonia or alcohol vapor. Remember, chlorine is heavier than air and flows to low levels. It kills vegetation and animal life of any kind when in its liquid or gaseous states.

Sulfur Dioxide

Sulfur dioxide is designated by the symbol SO_2 and has a specific gravity of 2.264. It is a very poisonous, colorless gas with a suffocating, irritating odor, and a pronounced taste. It neither burns nor supports combustion, but is very soluble in water, forming sulfurous acid without producing much heat.

Sulfur dioxide is used in bleaching, fumigation, and as a refrigerant in mechanical refrigerators. It is very irritating to the eyes and throat; hence it may be readily detected even in concentrations of less than 20 parts per million of air because it causes coughing. Before sulfur dioxide reaches a dangerous percentage in the air, a person will be unable to endure the pain of breathing such a mixture.

Ammonia

Ammonia, designated by the symbol NH_3, has a specific gravity of 0.597 and is a colorless gas with a sharp, burning taste and a penetrating, overpowering odor. It is used principally in ice plants, large refrigeration units, and petroleum refineries. Ammonia gas is extremely soluble in water. Traces of ammonia gas are also found in the outside air but in very minute quantities. When highly concentrated, ammonia gas attacks moist skin, especially the mucous membranes of the nose, throat, and lungs, causing tears, difficult respiration, strangulation, and suffocation.

When shutting off an ammonia leak, use an approved self-contained breathing apparatus to protect the nose and throat. Apply petroleum jelly to protect tender skin. Tie trouser legs to the ankles and coat sleeves at the wrist.

Nitrous Oxide

Nitrous oxide, designated by the symbol N_2O, is a colorless, transparent gas that is somewhat soluble in water. It has a specific gravity of 1.53 and a faintly sweet taste and odor. It is called "laughing gas" and is used by dentists as a mild anesthetic when extracting teeth.

This gas is formed by the action of nitric acid upon metals or organic material and by the burning of articles made of nitrocellulose, such as movie films, x-ray films, and other pyroxylin products. Nitrous oxide may also be formed by burning cotton or rayon cloth in air deficient of oxygen. Brushing lacquers, combs, and other pyroxylin toilet articles produces

N_2O when burning; therefore care should be taken around fumes emitted by the burning of such articles. It is possible to inhale an amount sufficient to be fatal without a great deal of discomfort at the time it is inhaled.

If inhaled for a short time, nitrous oxide causes nervous excitement, which is often manifested by laughter. If breathed in large quantities, it produces temporary unconsciousness and insensibility to pain. Nitrous oxide fumes seldom exist alone as a result of combustion, but are usually found in combination with nitric oxide and nitrogen tetroxide. When burning the mixture of the gases produces a deep orange-colored flame, and the fumes are extremely poisonous if inhaled.

Hydrogen Sulfide

Hydrogen sulfide, designated by the symbol H_2S, has a specific gravity of 1.2 and is a colorless gas with the characteristic odor of rotten eggs. It is always found near cesspools. This gas is so poisonous that one part in 200 parts air is fatal. Hydrogen sulfide is formed to some extent when woolens and rubber materials are burned. When burning, it decomposes into hydrogen and sulfur, forming water and sulfur dioxide.

Smoke

Smoke ordinarily encountered at a fire consists of a mixture of oxygen, nitrogen, carbon dioxide, some carbon monoxide, finely divided particles of soot and carbon, and a miscellaneous assortment of products from the combustion of wood and other materials. Its companions, dusts and mists, are tiny bits of dirt and small drops of water floating in air. Ordinarily these particles are not dangerous; however, continued breathing of the particles may cause discomfort. Dusts and mists can be removed by filtering them through a layer or two of cotton, wool, or some similar fine mesh. The fact that these particles can be so easily removed often gives a false sense of security to those who use cheap gas masks and respirators. Such inferior equipment offers no protection from the dangerous gases that are often found mixed with smoke.

Organic Vapors

Organic vapors are formed from well-known products that vaporize readily, such as chloroform, gasoline, and formaldehyde, and from the ordinary burning of materials such as wood and paper. Breathing organic vapors is merely irritating, while other vapors are very poisonous.

Acid Gases

Acid gases, such as chlorine, hydrogen sulfide, and phosgene, can be controlled only by neutralizing them with a product such as a caustic soda preparation. This group of gases is being used for many of the substances that produce refrigeration and is becoming more common in the home.

Rescuers must be aware of the potential explosion hazard with some of these gases. If there is doubt as to whether or not the gas is explosive, every precaution must be taken to prevent a spark. Light switches should not be turned on or off within the contaminated area. Portable hand lights or auxiliary electrical equipment should be carried on the rescue apparatus to be used in these areas. It is also important that equipment and tools made of ferrous metals be handled carefully to avoid creating sparks.

SCBA OPERATIONS

Trade or brand names mentioned in this text are supplied with the understanding that no discrimination or endorsement by the Instructional Materials Laboratory is implied or intended.

Since there is more than one manufacturer of SCBAs, it would be impossible to detail the operation of all the various brands. However, all masks manufactured today have the same basic components (see Figures 48-51).

The procedure presented here is for one brand of mask. Each rescuer should know the type of mask used in the department and become familiar with the use, inspection, and maintenance of the mask.

When actually using an air mask, proper protective clothing must be worn.

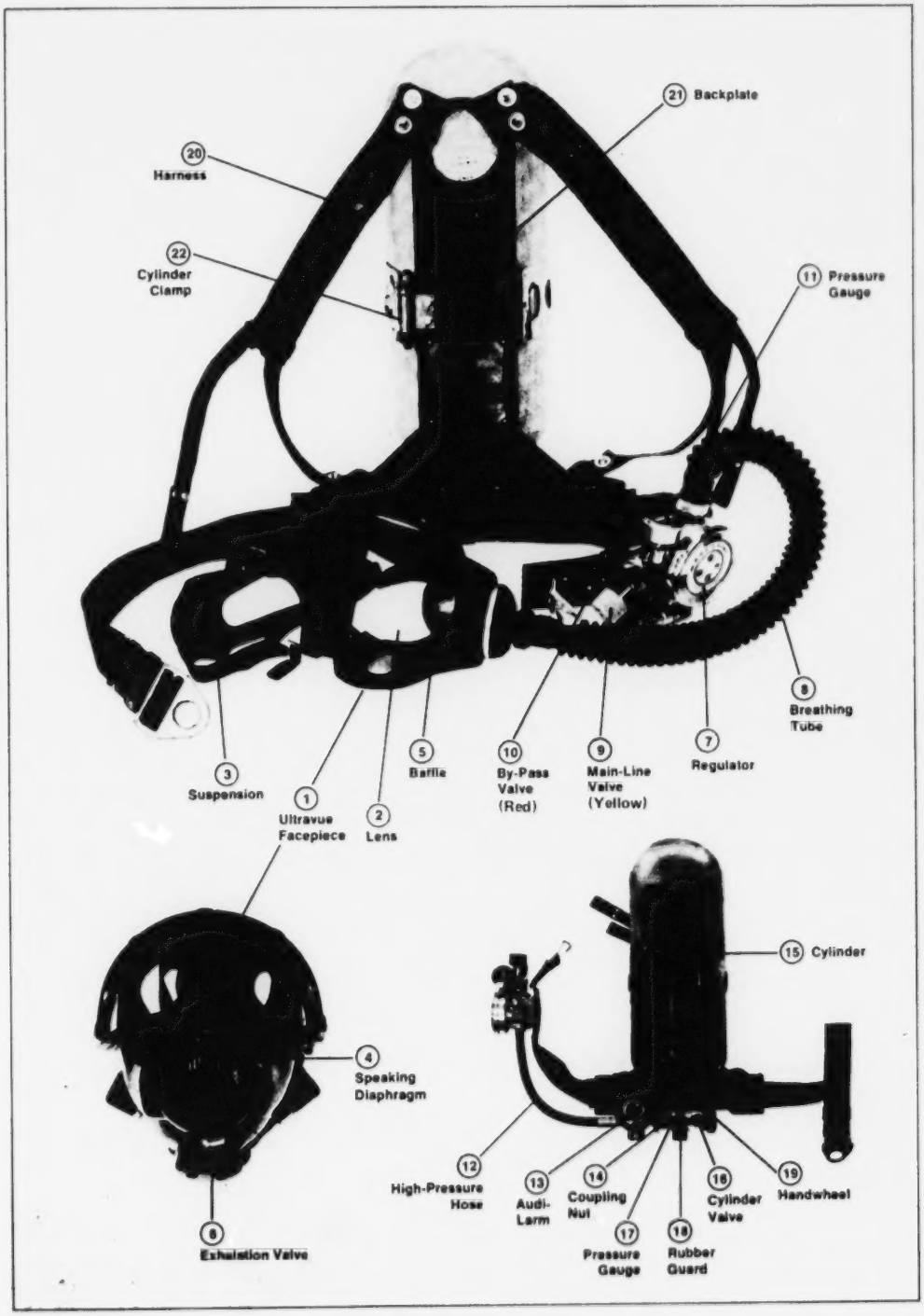

Figure 48. MSA Mask

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Figure 49. Scott SCBA

Figure 50. National Draeger, Inc. SCBA

Figure 51. Globe Guardsman SCBA

DAILY MASK CHECK

Tank and Regulator

1. Remove the mask from the apparatus and lay it on a flat surface with the gauge facing up.
2. Inspect the harness straps for damage or wear. Check all buckles to make sure they are functioning properly.
3. Check the cylinder pressure. If the cylinder pressure is below manufacturer's specifications, the cylinder should be changed.
4. Close the main-line and by-pass valves, and cover the regulator outlet.
5. Open the cylinder valve fully, the alarm should ring briefly.
6. Open the main-line valve approximately one-quarter turn until it clicks and locks open. Check the regulator gauge. Keep regulator outlet covered. Close the cylinder valve. The regulator gauge must not drop more than 100 psig in 30 seconds.
7. Very slowly uncover regulator outlet. Watch the needle drop. At approximately 1000 psig the alarm should ring. When the ringing stops, push the locking bar and close the main-line valve.

Facepiece

1. Remove the breathing tube from the facepiece. Check the gasket on the facepiece where the breathing tube connects. Check the gasket inside the regulator end of the breathing tube.
2. Thoroughly clean and check the facepiece for cuts, tears, and abrasions. Make sure the lens is intact and securely held in place by the lens ring.
3. Hold the air deflectors open with the fingers while blowing into the breathing tube connection on the facepiece to remove any debris in the air passage.
4. Visually check the exhalation valve on the inside of the facepiece for any foreign matter. Do not disassemble the exhalation valve. Make sure the exhalation valve is free and functioning. If the exhalation valve is sticking, the exhaled breath will escape past the seal around the facepiece.
5. Check the facepiece straps for cuts, tears, and abrasions. Make sure that the straps are fully extended.
6. Place the palm of the hand over the end of the breathing tube and inhale so the facepiece collapses, holding the breath for 10 seconds. The facepiece should remain collapsed while the breath is held, providing that the assembly is airtight and a seal formed around the face. Return the mask to the apparatus.

Do not make repairs or make-shift arrangements. The mask either works properly and is in service, or does not work properly and is out of service. There are no in-betweens. All repairs must be done by qualified personnel only. It is dangerous to make improper repairs.

DONNING PROCEDURE

Vest Method

Figure 52.
Check cylinder gauge and audible alarm. Then open cylinder valve.

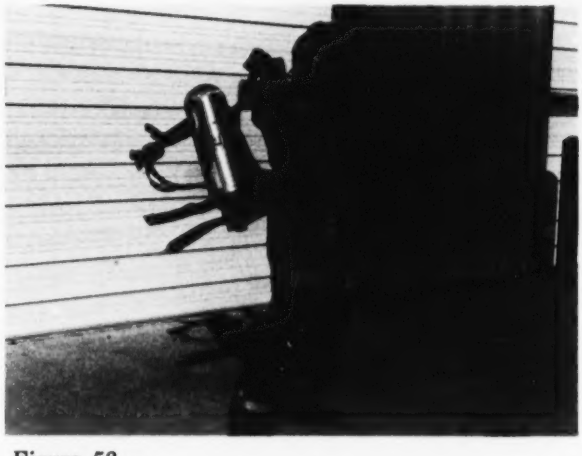

Figure 53.
Grasp right shoulder strap with right hand or left shoulder strap with left hand and swing SCBA over shoulder. Slip opposite arm into harness.

VEST METHOD (Cont.)

Figure 54.
Fasten chest strap, lean forward, and tighten shoulder straps.

Figure 55.
Fasten and tighten waist strap.

OVER-THE-HEAD METHOD

Figure 56.
Check cylinder gauge to be sure cylinder is full, and turn on cylinder valve.

Figure 57.
Grasp cylinder with both hands; straps should be on the outside.

OVER-THE-HEAD METHOD (Cont.)

Figure 58.
Raise SCBA over the head; allow straps to slide over arms.

Figure 60.
Lean forward and tighten shoulder straps.

Figure 59.
Grasp shoulder straps and allow SCBA to slide down on back.

Figure 61.
Fasten the waist belt and tighten.

DONNING FACEPIECE

Figure 62.
Grasp the facepiece straps with the thumbs and spread the facepiece wide. Insert chin in the mask and slip the straps over forehead.

Figure 64.
To don the helmet, slip the air hose over the chin strap.

Figure 63.
Tighten the bottom straps first. Tighten the temple straps next. Tighten the head straps last. These straps should be tightened by pulling straight back. **Do not pull them outward** as they may break.

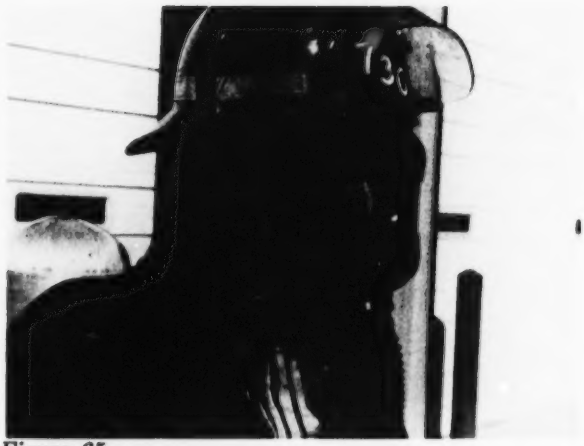

Figure 65.
Tighten the chin strap and connect the hose to the regulator.

GENERAL CARE

Care of the Facepiece

Wash the facepiece in a cleaner-sanitizer solution as needed, but at least once a week (use two ounces cleaner-sanitizer to one gallon of warm water). A mild detergent may also be used. Rinse in clear warm water. Dry with a towel or a low pressure air hose.

Care of the Exhalation Valve

Flush the exhalation valve with clear water. Make sure that no foreign matter is lodged in the exhalation valve. Care must be taken not to damage the spring inside the exhalation valve. If foreign matter cannot be dislodged by flushing with water, send the facepiece in for repairs.

Care of the Breathing Tube

Wash the breathing tube in the cleaner-sanitizer solution. Rinse in clear warm water. Stretch the breathing tube to allow the water to drain from the corrugations, and to check for cuts, cracks, and tears along the entire length of the tube. Check to see that the retainer clips in each end of the breathing tube hold the threaded fittings securely.

AIR CYLINDERS

Inspecting Steel Cylinders

Steel cylinders exposed to high heat or flame may have indications of the following:

- Paint turned to brown or black color
- Charred or missing decals
- Melted gauge lens
- Melted valve parts
- Dents
- Creases
- Gouges
- Chips

Any cylinder with the conditions listed above should be removed from service, checked, repaired, and retested before returning to service.

Inspecting Composite Cylinders

All cylinders should be inspected routinely for the following:

- Neck cracks, folds, or other flaws. (Neck cracks are normally detected by testing the neck with a soap solution during the charging operation.)
- Cuts, digs, and gouges.
- Flaws or cuts in the overwrap of the cylinder exceeding .09" in depth and 1.0" in length.
- Abrasions. (Cylinder abrasions should not total more than four square inches of surface area or exceed .045 inches in depth.)
- Loose bands of fiber peeling from the cylinder.

Any cylinders with any of the above conditions should be removed from service for repair or replacement.

Composite cylinders exposed to high heat or flame may have indications of the following:

- Charred or burned overwrap
- Burned or sintered cylinder surface
- Distorted cylinder or cylinder valve
- Safety relief devices that have operated
- Melted valve parts

Hydrostatic Testing

Before filling SCBA cylinders, it is important to check the hydrostatic date. Any cylinder that is due to have a hydrostatic test should not be filled.

Steel cylinders should be tested every five years.

Composite cylinders should be tested every three years.

If any cylinder is suspect, due to any of the criteria listed, it should be returned to the manufacturer immediately for repairs.

Changing Cylinders

1. When changing cylinders, make sure the cylinder valve is closed. If there is pressure on the regulator, bleed off the pressure.
2. Remove the high pressure line from the cylinder valve. Disengage the cylinder lock and remove the unserviceable cylinder.
3. Check the new cylinder to see if it is full (2000 psi or more).

4. Momentarily crack the cylinder valve to blow out any dirt or debris that may be in the valve orifice.
5. Visually check the cylinder for damage, defects, etc., and make sure it is within the hydrostatic test interval.
6. Place the full cylinder on the back plate with the cylinder valve gauge up, and engage the cylinder lock. Make sure the cylinder lock holds the cylinder tightly.
7. Attach the high-pressure hose to the cylinder valve hand tight.

Cascade System Procedure

A cascade system of air tanks includes two or more tanks (300 cubic feet each) that are connected in a series. The cylinders used in the cascade system should be of the same size, and should be larger in volume and higher in pressure than the cylinders to be filled (see Figure 66).

Figure 66. Cascade System of Tanks

When filling SCBA cylinders from a cascade system, begin filling from the SCBA cylinder with the lowest pressure and open only one cylinder at a time. Once the SCBA cylinder being filled reaches the same pressure as the cylinder on the cascade system, close the cascade cylinder and go to the cascade cylinder with the next highest pressure. Repeat this procedure until the SCBA cylinder has reached the rated fill pressure. A suggested sequence for filling SCBA cylinders follows:

1. Make sure the cascade system cylinder valves, manifold valve, and bleeder valve are closed.
2. Open the CYLINDER VALVE of the cylinder with the lowest pressure in the system.
3. While holding the fill line in one hand, crack the MANIFOLD VALVE and blow out the fill line for three seconds.
4. Close the MANIFOLD VALVE.
5. Crack open and close the CYLINDER VALVE of the cylinder to be filled, and place it in a water-filled safety jacket. Do not let water come into contact with the CYLINDER VALVE, and do not place composite cylinders in water.
6. Connect the fill line to the CYLINDER VALVE.
7. Open the CYLINDER VALVE of the cylinder to be filled and note the reading on the gauge that is located on the FILL LINE of the cascade system. Do not use the small cylinder gauge.
8. Find the lowest pressure cylinder in the system that is at least 200 psi higher than the cylinder to be filled, and open the CYLINDER VALVE.
9. Slightly open the MANIFOLD VALVE and allow the air to transfer slowly.
10. When pressures have equalized, close the MANIFOLD VALVE, and then close the CYLINDER VALVE.
11. Open the CYLINDER VALVE of the next highest pressure cylinder.
12. Repeat steps 9 and 10.
13. Repeat steps 11 and 12 until the rated fill pressure has been achieved.
14. Close all CYLINDER VALVES and the MANIFOLD VALVE.
15. Open the BLEEDER VALVE on the fill line.
16. With the BLEEDER VALVE open, slightly open the MANIFOLD VALVE.
17. When the system is bled down, close the MANIFOLD VALVE and the BLEEDER VALVE.
18. Remove the filled cylinder.

All cylinders should be filled slowly. This helps prevent heat build-up, which causes the pressure in the cylinders to drop when the cylinder cools. Filling a cylinder at a rate greater than 500 psi per minute can seriously fatigue the cylinder walls.

EMERGENCY PROCEDURES

Breathing Difficulty

A rescuer who has difficulty breathing should check to see that the breathing tube is not pinched or restricted. Also, check the regulator pressure gauge, as the alarm may not be functioning. If breathing difficulty is due to mechanical failure, do the following:

1. If the SCBA contains enough air to leave the area without using the BYPASS VALVE, do so.
2. If the BYPASS VALVE must be used, open it slowly and adjust the flow; then close the MAINLINE VALVE.
3. Leave the contaminated area immediately with someone whose SCBA is operative.

No Air Flow

A rescuer who discovers no air flow should follow these steps:

1. Open the BYPASS VALVE slowly and adjust the flow.
2. Close the MAINLINE VALVE.
3. Leave the contaminated area immediately with someone whose mask is operative.

Severed Breathing Tube or Inoperative Facepiece

A rescuer who discovers a severed breathing tube or an inoperative facepiece should follow these steps:

1. Remove the breathing tube from the regulator outlet.
2. Remove the facepiece.
3. Remove the right arm from the harness strap.
4. Breathe directly from the regulator outlet, inhaling through the mouth and exhaling through the nose.
5. Leave the contaminated area immediately with someone whose mask is operative.

All problems with the SCBA and malfunctioning masks must be reported.

MISCELLANEOUS CONSIDERATIONS

All rescuers should be aware of the following considerations and limitations of the SCBA and be prepared to deal with them accordingly.

Cold Weather Precautions

In very cold weather moisture in the air supply may freeze and stop the flow of air. The nosecup in the facepiece must be used to help retard facepiece fogging and exhalation valve freezing.

When removing breathing apparatus in or near subzero weather, attempt to place it in a warm environment to prevent freezing. The facepiece may be placed inside the turnout coat.

Low-pressure alarms may fail at subzero temperatures. Be sure to check the regulator pressure gauge. The SCBA is approved for use in temperatures to -25 degrees F. If it must be used in temperatures below -25 degrees F , extreme caution should be used. High-pressure connections may develop small leaks due to metal contraction at low temperatures.

Corrective Lenses

Corrective lenses, if required, should be fitted in the facepiece with mounting devices available from the manufacturer. Corrective glasses that have temple bars that pass between the sealing surface of the facepiece and the wearer's face should not be used.

Personnel who wear contact lenses should not wear the SCBA. One or both lenses could pop out from the pressure of the facepiece at the side of the eye, or dust could be blown upward by the incoming air and forced between the lens and the pupil of the eye.

Facepiece Sealing (NFPA 1500, 5-3.9; 5-3.10)

Facial hair interferes with the facepiece-to-face seal and the operation of the exhalation valve. Beards are not permitted. Head coverings, spectacle temple bars, and any other protuberance that passes between the sealing surface of the facepiece and the face are not permitted.

Use at Pressure Greater Than Atmospheric

The air mask is designed and calibrated to operate at normal atmospheric pressure. The use of the mask at greater pressure causes uncontrolled free flow and minimal service life. Therefore, the mask should never be used at pressure greater than atmospheric, which occur, for example, in underwater operations.

CONCLUSION

As stated earlier, the self-contained breathing apparatus is one of the most important pieces of equipment the rescuer will ever need to use. It is essential that all rescuers learn to wear and take care of the SCBA properly.

Many fire departments have a policy that no rescuer without a mask shall enter a building filled with smoke. It is felt by some that no rescuer should respond to any fire emergency without a mask. As stated in the fire service, "Take care of your mask and it will take care of you."

EMERGENCY VEHICLE OPERATION

KEY POINTS

- Vehicle maintenance
- Legal aspects of operating an emergency vehicle
- Responsibilities of the emergency vehicle driver
- Emergency warning systems
- Driving techniques, including defensive driving
- Hazards encountered by the emergency vehicle driver
- Arrival at the emergency scene
- After the run

INTRODUCTION

Each year a significant number of emergency vehicles is involved in highway accidents. Such accidents can cause injuries, property loss, and even death. When an accident occurs, a community can suffer passenger injuries, as well as many losses, including loss of the emergency service vehicle, the personnel, and equipment and tools.

LEGAL ASPECTS OF OPERATING AN EMERGENCY VEHICLE

Laws are written to govern and protect the emergency vehicle driver and allow a quick, safe response to an emergency. Drivers must be aware of all laws because, in the event of an accident, the laws will be examined carefully by courts and law enforcement officials to determine the accident cause. All laws are subject to interpretation that depends on the situation and the people interpreting the law.

The first question asked in an accident involving an emergency vehicle is, "Was there a true emergency at the time of the accident?" The U.S. Department of Transportation defines a true emergency as:

> A situation in which there is a **high probability of death or serious injury to an individual or significant property loss,** and action by the (emergency vehicle) operator may reduce the seriousness of the situation.

This definition is broad, and remains open for interpretation. In most cases the initial response to the scene is considered an emergency. This is true for two reasons: (1) The caller may not know what is life threatening, or may be panicking, and therefore, may not give sufficient or accurate information to the dispatcher. (2) Vague information is often given to the emergency crew by a dispatcher who is not qualified to evaluate the emergency.

The second question asked is, "At the time of the accident was the emergency vehicle driver showing due regard for the safety of others?" Almost every law pertaining to emergency vehicles contains the phrase "due regard for safety." The definition of due regard, according to the U.S. Department of Transportation is:

> A reasonably careful person, performing similar duties and under similar circumstances, would act in the same manner.

When looking at due regard from the safety aspect, law enforcement officials, courts, and others will be examining the following details:

- Was appropriate warning given to the public?

  Were both visual and audible signals being used at the time of the accident?
- Was the emergency driver giving other drivers a chance to react to the situation and to yield the right-of-way?
- Was the speed of the emergency vehicle appropriate for the weather and the road conditions?

The law gives the emergency vehicle driver privileges only if asked for in a proper manner. Use turn signals and emergency lights, sound the siren, and provide adequate time for other drivers to pull to the curb lane, stop their vehicle, or motion for the rescue vehicle to proceed. Emergency vehicles can then proceed with due regard.

When evaluating an accident, the court will review the emergency vehicle driver's qualifications, background, and training. All types of training and skills are evaluated. The more experience and training a driver has in emergency vehicle operation, the more likely the court will be to rule in favor of the driver. For this reason, it is recommended (especially by insurance companies) that the emergency vehicle driver have special training in defensive driving techniques.

Each emergency service should thoroughly evaluate the requirements for driving an emergency vehicle. An emergency department can save money in insurance premiums, court settlements, and vehicle repairs by being sure a driver is qualified to drive an emergency vehicle. When an unqualified person drives an emergency vehicle, the courts, law enforcement officials, and insurance companies tend to look unfavorably on the emergency service.

The emergency vehicle driver must realize how important it is to stay within all the laws written for the safe operation of motor vehicles. The driver must do everything possible to prevent an accident and, in the event of an accident, must realize that he or she may be held accountable and fully responsible for the incident.

Even though there are laws providing relief of liability for emergency vehicle drivers responding to a call, the driver must realize this provision applies only if a true emergency exists and due regard for safety of others is observed. In the event of a serious injury or illness, rapid response to the scene is required, but personal safety and protection should never be sacrificed.

RESPONSIBILITIES OF THE EMERGENCY VEHICLE OPERATOR

Pass a Vision Screening Test

Emergency vehicle drivers must remain alert and maintain a visual awareness while driving the vehicle. To perceive a dangerous situation one must have good vision. In many states, those obtaining a new license or renewing a license must pass a vision screening test indicating that they have adequate vision for driving. Those failing the vision test will not receive a driver's license.

Use Seat Belts

Seat belts are basic safety devices designed to keep the occupants of a vehicle in place in the event of an accident. In addition to the safety value of a seat belt, if the emergency vehicle moves in an unpredictable manner a fastened seatbelt keeps the personnel in position, allowing the driver to more effectively control the vehicle. Many states have passed laws requiring each vehicle driver and passenger to wear a seat belt when a vehicle is in motion.

Know the Geographic Area

It is important that all emergency vehicle drivers know the geographic area they serve and their exact destination before the vehicle is in motion. Not knowing the area or the best route of transit delays response time, possibly making the difference between life and death.

Prepare the Vehicle

At the start of each work shift, adjust the seat so the accelerator, brake, and steering wheel can be accessed safely and comfortably for vehicle control. Along with the seat, adjust all rearview and side mirrors so there is clear visibility on both sides of the vehicle.

Emergency Warning Systems

Lighting. Most states require an emergency vehicle to be equipped with at least one revolving or flashing light. Many different types of emergency lighting systems on the market meet the basic requirements.

There are several considerations in selecting and using an emergency lighting system. Emergency lights should warn motorists that there is an emergency vehicle approaching or at the scene. It is important to make sure that emergency lights do not hypnotize, overpower, or blind the onlooker.

All emergency lights should have the following characteristics:

1. Lights should be highly visible during the day and at night.

2. Lighting should be of paired colors. No single color satisfies the requirements.
3. Long flashes are better than short, because they give oncoming traffic sufficient time to perceive an emergency signal.
4. Clearance lights should outline the entire vehicle, both front and rear, to allow others to recognize the type of vehicle at the scene.

Sirens. As with vehicle lighting, most states have a law requiring an emergency vehicle to be equipped with an audible warning device. This can vary from an air horn to a mechanical or electrical siren. An emergency vehicle is likely to be seen before it is heard.

A recent study done by the U.S. Department of Commerce National Bureau of Standards investigated the inside atmosphere of vehicles and found that when a siren is sounded loud enough to penetrate the sound into the average vehicle, it would be unbearable to the unprotected human ear. Sirens have limitations, especially to the traffic approaching from the rear, since the sound is normally directed to vehicles in front of the emergency vehicle.

Consider the following items when selecting and using a siren:

Use sirens with varying pitches ranging from high tones to low tones, so they can be heard by all drivers on the road. Yelp and other types of quick-changing cycles of sound are more suitable for urban areas where sound can be spread out and bounced off buildings. In rural and open areas, the wail and other long-cycle sounds carry farther and are more effective.

At intersections, allow the siren to cycle down so noises from trains, trolleys, and sirens from other responding vehicles, can be heard by the emergency vehicle driver. People who are deaf will not hear a siren no matter what type of audible device is used. For the benefit of the deaf driver or the driver who is deaf to certain tones, other warning devices should be used to draw attention to the vehicle and allow the driver to yield the right-of-way.

Sirens must be sounded whenever an emergency vehicle violates normal traffic regulations. When driving at a high speed, the emergency vehicle can outrun the sound of the siren. The siren does not travel as far when the emergency vehicle is moving at a fast speed as it does at a slower speed, and the emergency vehicle will be close to a motorist when the driver hears the siren. The emergency vehicle driver must be prepared for quick stops and abnormal reactions from other drivers.

DRIVING TECHNIQUES

Defensive Driving

Defensive driving means driving to prevent accidents in spite of the actions of others or in the presence of adverse driving conditions. One of the most important factors in defensive driving is the correct perception of the traffic environment. Perception means the driver's ability to see and understand driving hazards.

Defensive driving involves four major areas:

1. Identifying a hazard, i.e., knowing what conditions can cause an accident
2. Predicting what might happen ahead on the road
3. Deciding what action to take when a hazard is encountered
4. Performing maneuvers to avoid a hazard

The following defensive driving techniques give drivers an advantage in preventing an accident:

Steer to Avoid Hazards. A driver cannot always depend on the brakes to stop a vehicle in time to prevent an accident. It is sometimes necessary to steer a vehicle away from an accident or hazard.

Reduce Speed in Adverse Weather. Adverse weather can impair the driver's visibility and control of the vehicle.

Look Ahead. The driver should try to predict movements of traffic and pedestrians, and be prepared for the worst.

Follow at a Safe Distance. To prevent a rear-end collision the driver should use the two-second method described below to determine the appropriate distance between the emergency vehicle and the vehicle ahead.

To avoid potential hazards, the emergency vehicle must be in a position that provides the best field of vision for the driver and the greatest potential to be seen by others. The greatest risk of a collision is in front of the vehicle, so it is critical to maintain a large gap (called **following distance** or **space**

cushion) between the emergency vehicle and the vehicle ahead in the same lane in order to see beyond the vehicle.

When traveling in normal traffic in good weather conditions, a time gap of two seconds between vehicles works well. At 30 mph, a vehicle covers 44 feet per second, or about five car lengths in two seconds. A two-second gap allows a driver to see around the vehicle ahead and quickly change lanes if necessary, assuming there are clear areas to the sides. This two-second gap also allows the driver to stop if the car ahead suddenly brakes.

To use the two-second rule, pick out a stationary object (e.g., a tree or telephone pole) in the path ahead. When the vehicle ahead passes this stationary object, count "one thousand and one, one thousand and two." If you arrive at the location of the object before saying, "one thousand and two," you are following the vehicle in front too closely and need to allow more following distance.

When following a vehicle too closely it may be necessary to stop suddenly to avoid a collision. Stopping a vehicle involves more than just stepping on the brakes. Stopping a vehicle involves perception time, reaction time, reaction distance, braking distance, and road conditions. It is important to remember that on a wet or icy road it takes longer to stop, so the following distance must be increased when such weather conditions exist.

Controlling the Vehicle

An emergency driver must always have the vehicle under control. The faster a vehicle is traveling, the harder it is to steer to avoid a collision and the longer it takes to stop the vehicle. Driving at a sensible speed (usually the posted speed limit) gives the driver more control over the vehicle.

At an intersection, slow the speed by moving the foot from the accelerator to the brake. This technique allows adequate time and space to react safely and avoid an accident.

Perception time is the driver's ability to foresee a potentially dangerous situation. It is the time between seeing a danger and identifying it. Perception time varies with each individual. Two factors that influence perception time are mental alertness and visual activity.

Reaction time is the time it takes to react and take the needed action in a situation. The average reaction time for most drivers is 3/4 of a second, but this varies from person to person.

Reaction distance is the distance it takes to decide on the appropriate action and react.

Braking distance is the distance a vehicle travels from the time the brakes are applied until it comes to a complete stop. Braking distance increases as the speed of the vehicle increases. For example, a car traveling at 50 mph needs four times the braking distance of a car traveling at 25 mph under the same conditions.

The total **stopping distance** of a vehicle is equal to the reaction distance plus the braking distance. The chart indicates the distances (in feet) for reaction distance and braking distance for various speeds (see Figure 67.)

An example of stopping distance is: if a vehicle is traveling at 40 mph, it would take 44 feet to react and 73 feet to brake, for a total distance of 117 feet before the vehicle comes to a complete stop. When more weight and speed are added to a vehicle, the stopping distance increases. To decrease the overall stopping distance, take the braking foot from the accelerator and intermittently place it on the brake pedal. This procedure eliminates most of the reaction distance, therefore cutting down on the total stopping distance.

SPEED MPH	REACTION DISTANCE	+	BRAKING DISTANCE	=	TOTAL STOPPING DISTANCE
60	66′		184′		250′
55	61′		150′		211′
50	55′		119′		174′
45	50′		83′		133′
40	44′		73′		117′
35	39′		53′		92′
30	33′		40′		73′
25	28′		28′		56′
20	22′		20′		42′

Figure 67. Stopping Distance Chart

DRIVING TECHNIQUES WHEN RESPONDING TO AN EMERGENCY

The following driving techniques should be followed when responding to an emergency:

Pass With Care

When attempting to pass or overtake a vehicle, make sure the passing lane is clear.

Back Cautiously

When backing the vehicle, always check the rearview clearance and have someone guide if possible. Always use the side and rearview mirrors for assistance.

Steer into a Skid

If the vehicle goes into a skid, steer in the direction of the skid. Do not apply the brakes. If the brakes are applied, the front wheels stop moving and steering control is lost.

Keep Both Hands on the Wheel

For safe vehicle operation and to keep the vehicle under control, keep both hands on the steering wheel. Use the ten-and-two hand position to give a wide range of motion and control. Never cross hand-over-

hand while driving. Make sure one hand is always grasping the wheel. The riding personnel should handle the siren, radio, and other instruments, allowing the driver to concentrate on driving.

Drive with a Window Open

Leave a window open so sirens from other emergency vehicles and road noises can be heard. Watch for trains, other vehicles, pedestrians, and any signal identifying a potential hazard.

Keep Speed within Controllable Limits

Speed kills! This is no exception for emergency vehicled drivers. It is unlikely a driver is going to preserve a life by racing to the scene of an emergency. Very little time is saved by exceeding the speed limit. In a two-mile vehicle run the difference between driving 40 mph and 60 mph is approximately one minute. One minute is hardly worth the risk of being involved in an unnecessary accident.

Steer to Avoid Obstacles

When an obstacle appears, the driver's reaction is to slam on the brakes, but doing this does not allow the driver to maintain control of the vehicle. In most cases, defensive driving such as steering around the object is more effective than trying to stop completely. Using a combination of steering and fanning the brakes allows the driver to bring the vehicle under control.

Fan Brakes When Attempting to Stop

To keep a vehicle under control when guiding it during a stop, keep the front wheels rolling. To keep the front wheels rolling while simultaneously stopping the vehicle, apply the brakes in a quick on-off motion (known as fanning). This procedure not only helps stop the vehicle, but is very important for skid control when traveling on wet or icy pavement. This procedure takes time to learn, but when applied properly it gives the driver more control of the vehicle.

Stop at All Red Lights and Stop Signs

Expect the unexpected, particularly at intersections. It is unrealistic to assume that everyone sees an emergency vehicle at an intersection. At intersections, stop to gain the right-of-way, then proceed cautiously.

Look to the Left First at Intersections (Left, Right, Left)

In most cases, traffic at an intersection comes from the left first because this lane is closest. At all intersections, look left first, then right, then left again. This allows complete visual inspection of an intersection and an opportunity to scan for hazards. If an area has a blind spot, always stop before entering the intersection.

Stop for All Stopped School Buses

The law requires all oncoming and following vehicles to stop when a school bus is stopped to load or unload passengers. Never attempt to pass a school bus that is stopped with the red lights flashing. Children may dart into the roadway.

Slow Down in All Pedestrian Zones

Most states have a law that pedestrians must yield the right-of-way to vehicles; however, common sense dictates slowing down in pedestrian zones. Older people sometimes have trouble reacting quickly, and children tend to come running when they hear a siren. Be prepared for the unexpected, especially when visibility is poor.

Exercise Caution When Passing Another Emergency Vehicle

When more than one emergency vehicle is responding along the same route it may be necessary for one vehicle to pass the other. If this situation occurs, it is common courtesy for the passing driver to ask permission from the driver of the vehicle in front and wait for an all-clear signal before passing. If communication is not possible, continue to follow at a safe distance (500 feet).

Give Other Drivers a Chance to Yield Right-of-Way

Most emergency vehicle accidents can be prevented by exercising good driving techniques. An emergency vehicle driver must be aware of both approaching traffic and the traffic moving in the same direction. The emergency vehicle driver should do the following:

- Pass a vehicle only on the left side.
- Always use turn signals.
- Always use lights and siren together.

Pass Only on the Left

Pass other vehicles on the left side only. In a normal driving situation most drivers pass another vehicle on the left side and the emergency vehicle should do the same. Most states have a law that requires drivers to pull to the right side of the road and stop, yielding the right-of-way to an emergency vehicle traveling with flashing lights and sounding an alarm.

Always Use Turn Signals

Always use the turn signals, even with the other emergency lights, so other drivers know what route is going to be taken. Make moves deliberately and well ahead of time. Do not wait until within ten feet of a vehicle to signal and pull out to pass. Give other drivers time to react.

Always Use the Lights and Siren Together

Remember, the emergency vehicle driver has special rights or privileges only when other drivers yield the right-of-way. Use both visual and audible signals to give other drivers every chance to yield.

HAZARDS ENCOUNTERED BY THE EMERGENCY VEHICLE DRIVER

Drivers encounter many hazards when operating an emergency vehicle. The driver must continually remain aware of the following potential conditions:

Tailgaters

To deal with tailgaters, drive slowly and encourage them to pass and move ahead. Always signal intentions and make all stops smoothly to avoid a sudden stop.

School and Playground Areas

Children often run to the curb and sometimes into the street when they hear a siren or see flashing lights. Watch for children running into the roadway.

Deaf Drivers

Deaf people are allowed to operate motor vehicles but they cannot hear a siren or a public address system. Be sure the emergency lights are flashing to warn deaf people of an approaching emergency vehicle.

Other Drivers

Some drivers lock up the brakes and others pull to the wrong side of the street when they hear a siren or see flashing lights. Others may freeze in the middle of an intersection. Watch for uncommon turns or exits.

Soundproof Vehicles

Vehicles today are built for comfort and are often soundproof. Sometimes a driver gets into a vehicle, turns on the radio and other accessories and shuts out the rest of the world. This driver may not realize an emergency vehicle is sounding an alarm. Watch for drivers who do not hear an approach.

Thrill Seekers

Thrill seekers who decide to follow an emergency vehicle can become a hazard, not only to the emergency personnel but to the general public. When someone is following a vehicle responding to an emergency too closely and is a potential hazard, notify the appropriate law enforcement agency.

Other Emergency Vehicles

When following another emergency vehicle, be prepared to slow, stop, or turn, especially at intersections. Once the first vehicle goes through an intersection, traffic may not expect a second emergency vehicle and may enter the intersection.

Sirencide

Sirencide is a term used for the hypnotic effect produced when everything seems to be going well and the driver is lulled into a false sense of security. With the speed of passing objects, the sound of the siren, and the process of people moving to the right, the emergency vehicle driver often becomes unprepared to react. To prevent this situation, stay alert and be prepared to deal with the unexpected.

All emergency vehicle drivers are encouraged to complete the National Safety Council's defensive driver program to become more aware of the importance of driving defensively.

ARRIVAL AT THE EMERGENCY SCENE

Placing Apparatus at the Scene

When arriving at the scene of an emergency, the incident commander must first consider placement of apparatus. Personnel should be able to work between the scene and the emergency vehicle without delay. Position the rescue vehicle close to the scene to allow optimum use of tools, supplies, and lighting equipment. Determine which apparatus and/or equipment is needed immediately, i.e., ambulance for the injured, rescue for trapped victims, or fire-fighting equipment. Once the priority of equipment has been established, designate a place for each piece as it arrives on the scene.

When dealing with highway accidents, have a preplan for the optimum use of equipment and personnel (see Figure 68). The plan may have to be adjusted, however, to fit the individual circumstances of the emergency.

Figure 68. Preplan

These guidelines should be followed for equipment placement:

Ambulance. Position the ambulance past the scene to allow quick access to the victim care area and allow for rapid departure from the scene. Make sure the ambulance is not blocked or detained by other emergency vehicles or surrounding traffic.

Rescue vehicles. Position the rescue vehicle close to the scene to allow the use of tools, lighting, and equipment.

Fire-fighting equipment. Position the fire apparatus behind rescue personnel with hose lines laid down the curb side of road.

Position the vehicle of the incident commander at a distance from the scene to allow easy movement of apparatus.

At an incident involving hazardous materials, position fire apparatus near the scene, but uphill and upwind from the fire or spill. If hazardous material placards are displayed and can be seen when approaching the scene, do not rush to the spill until the identity and danger of the substances can be confirmed. Rescue vehicles and equipment should be near the scene for use of lighting and necessary tools and equipment. Locate ambulances away from the scene, with a medical-staging area set up for injured victims. Position the vehicle of the incident commander away from the scene to evaluate the scope of the emergency.

Displaying Warning Devices

The law states that if a vehicle stops or there is an emergency on a highway, adequate warning devices to warn oncoming traffic of danger must be displayed both in front and to the rear of the accident. Use flares, flags, reflectors, and the warning lights of the emergency vehicle to alert people of the emergency. Secure a safe work area as quickly as possible. The emergency driver can perform these tasks while other crew members are attending to accident victims. Secure a minimum area of at least 100 feet both to the front and the rear of the accident scene. Secure a longer distance if the scene is on a curve or a hill (see Figures 69-A and 69-B).

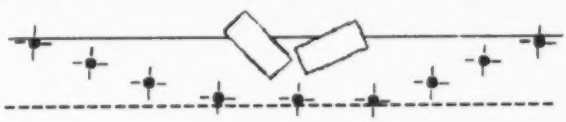

Figure 69-A. Display of warning devices on a straight section of road

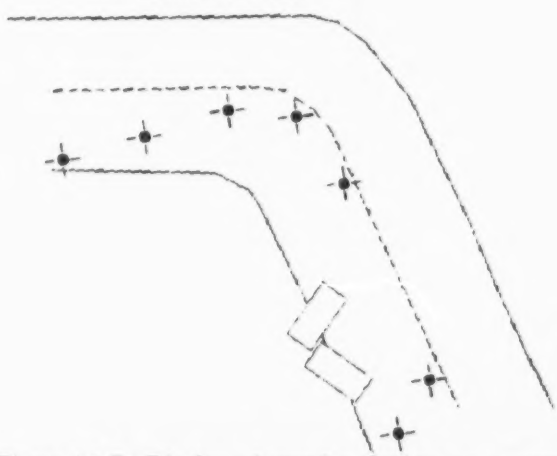

Figure 69-B. Display of warning devices on a curve section of road

Keeping Traffic Moving

Even though it is not the emergency vehicle driver's primary job, he or she should direct traffic at the accident scene if possible until law enforcement officials arrive. If possible, keep one lane of traffic open to keep vehicles moving and provide quicker access for assisting units.

Keep the emergency lights flashing at the scene of the emergency. When on a highway, the lights provide protection of the scene by warning approaching traffic of an apparent hazard. At a residential scene, especially at night, the flashing lights allow assisting units to quickly identify the emergency location.

If an emergency is located at a residence that is a distance away from the road, and the sight of the emergency vehicle is hidden, drop a highway flare at the driveway entrance to assist others in locating the scene. Anything that might make identification of the scene easier assists both the rescuers and the victim.

Do not drive the emergency vehicle on an off-road surface. Most emergency vehicles are not suitable for off-road usage. Doing so can cause damage or get the vehicle stuck in the mud. If an emergency scene is away from a suitable roadway, walk to the scene carrying the equipment, or call for special equipment.

After the Run

After the emergency run has been completed, make sure everything is in its place and the vehicle is in condition to respond to the next emergency. Note any malfunction that might have occurred while on the run, and report it to a supervisor for correction. The driver should refuel the vehicle if necessary.

All equipment and tools should be left clean and in their proper places. Expendable items should be checked and replaced if necessary.

VEHICLE MAINTENANCE

Vehicle maintenance is very important for any emergency service. Vehicles must be in good operating condition to maintain an effective emergency service.

No matter what type of emergency service is provided, some maintenance must be performed by the vehicle driver. Each driver should know the location and function of the mechanical and electrical systems of the vehicle. The driver should know how to check and replace the different fluids the vehicle requires. Drivers should also be aware of potential vehicle malfunctions that could result in catastrophe if not taken care of immediately.

The driver should perform a vehicle maintenance check daily, preferably at the start of each shift, to make sure the vehicle is ready for use (see Figure 70). In the event a malfunction is suspected, it should be reported to the maintenance officer.

All emergency services should have an ongoing preventive vehicle-maintenance program to ensure a longer life for the vehicles and to possibly prevent an accident. A monthly maintenance schedule should be followed to routinely check each vehicle's operating systems such as the brake system, the electrical system, and the fuel system (see Figure 71).

Along with monthly checks, semiannual checks should be performed for major items such as the transmission system and the exhaust system (see Figures 72 and 73). The tires should also be rotated semiannually. Monthly and semiannual checks should be done by qualified mechanics who are familiar with all systems of the vehicle.

When maintenance and repairs are neglected, costly repairs may be incurred. A reliable vehicle plays an important role in providing safe, efficient public safety service.

DAILY VEHICLE MAINTENANCE CHECKLIST

	OK	Comments
Ignition		
Fuel		
Oil pressure		
Dash lights		
Heater, AC, defrost		
Windshield washer		
Radio		
Emergency brake		
Mirrors		
Siren (all positions)		
Headlights high and low		
Parking lights		
Brake lights		
Back-up lights		
Turn signals		
4-way flashers		
Dome lights		
Emergency lights		
Scene lights		
Spot lights		
Highway flares		
Battery water		
Battery #1		
Battery #2		

Daily Vehicle Maintenance Checklist (continued)

Oil level		
Radiator water		
Hand throttle		
Tire pressure		
Outside clean		
Inside clean		
Doors		
Locks		
Seat belts		

Unit Number ___ Mileage ___ Running Hours ___

Comments _____

_____

_____

_____

Driver's Signature _____

Date _____

Figure 70. Daily Vehicle Maintenance Checklist

MONTHLY VEHICLE MAINTENANCE

Unit # _____ Date

License Plate # _____

Fluid Levels

	OK	Comments
Fuel		
Oil		
Coolant		
Battery #1		
Battery #2		
Transmission		
Brake		
Windshield washer		

Comments _____

Tire Pressure

PSI Condition E = Excellent G = Good F = Fair NR = Needs Replaced

Comments _____

Electrical System

	OK	Comments
Headlights		
Foglamps		
Wipers & washer		
Back-up lights		
Back-up alarm		
Brake lights		
Marker lights		
Turn signals		
License plate light		
Horn		
Air horn		

Emergency Lighting

	OK	Comments
Twinsonic		
Red flashing		
Rear beacons		
Scene lights		
Safety-bar lights		
Exterior cabinets		

Monthly Vehicle Maintenance Checklist (continued)

Interior Lighting

	OK	Comments
Dash lights		
Front dome light		
Map light		
Blue pt. light		
Rear dome light		
High		
Power vent		
Battery-charging system		
Oxygen system		
110 v inverter		
Shoreline system		

Comments _____

General Checklist

	OK	Comments
Fan belt tension		
Exhaust system		
Battery terminals		
Air filter		
Leaf spring and shocks		
Exterior body condition		

Lubricate the Following:

Chassis and moving parts
Accelerator linkage
Door hinges, locks, and latches
Brake linkage
Transmission kick-down linkage

Oil and Filter Change

Mileage _____ Comments _____

Engine Hrs. _____

Servicing Mechanic _____

Overall Comments _____

Figure 71. Monthly Vehicle Maintenance

VEHICLE MAINTENANCE SIX MONTH OR ANNUAL CHECKLIST

Unit # _____ Date

Engine Tune Up

	OK	Comments
Fuel filter replacefment		
Spark plugs replaced		
Ignition system		
Idle speed		
PCV replaced (annually)		
Air-filter replacement		
Ignition wires		
Dwell and timing		
Choke system		

Comments _____

General Maintenance

	OK	Comments
Check brake linings, lines, drums, and disc		
Check cooling system hoses and clamps		
Flush and replace coolant system (annually)		
Replace fluid and filter in transmission (annually)		
Adjust bands in transmission (annually)		
Rotate and check tires		
Repack and adjust wheel bearings (annually)		
Check batteries and recharge if necessary		
Check air conditioning system		
Check headlight alignment		
Replace wiper blades		
Check steering linkage		
Check driveshaft		
Check wheel nut torque		
Check fuses, fusebox		
Check module hold-down bolts		
Check inside cabinet bolts		
Check vehicle interior — floors, walls, seats, etc.		
Check for any loose parts, nuts or bolts		

Comments _____

Figure 72. Vehicle Maintenance Six Month or Annual Checklist

VEHICLE MAINTENANCE SIX MONTH REPORT

Unit # _____

Total mileage since last check _____

Total engine hours since last check _____

Total number of runs for the vehicle _____

Amount of fuel used in the last 6 months _____

Amount of oil used in the last 6 months _____

Vehicle's outside condition _____

Vehicle's inside condition _____

Major repairs completed in the last 6 months _____

Major parts replaced in the last 6 months _____

Accidents and/or damage in the last 6 months _____

Vehicle's current status _____

Mechanic _____ Date _____

Figure 73. Vehicle Maintenance Six Month Report

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CONCLUSION

An emergency vehicle driver assumes risk, responsibility, and liability when responding to an emergency call. To ensure the safety of public safety personnel, victims, and the general public, the emergency vehicle driver must become familiar with the state and local laws, operation of the vehicle, and defensive driving techniques. The vehicle driver must practice safe driving by remaining alert and being prepared to address many unknown and uncontrollable situations during each emergency response.

PROTECTIVE CLOTHING

KEY POINTS

- **Standards for protective clothing**
- **Characteristics of each of the three types of protective clothing**
- **Factors that influence the type of protective clothing selected**
- **Permeation, penetration, and degradation**

INTRODUCTION

Rescue personnel often encounter emergencies that require the use of protective clothing. Rescuers working at the scene of transportation, industrial, commercial, farming, or residential accidents may be required to wear special protective clothing in order to perform a safe and efficient rescue without endangering themselves unnecessarily. When rescuers respond to an emergency involving hazardous materials the incident commander should monitor the environment to determine the exposure rescuers will be permitted. Since many situations are beyond control of the rescue personnel it is important to maintain a high awareness of safety during each rescue response.

Protective clothing standards have been written to protect the rescuer from hazardous environments. The following national agencies have set standards:

1. National Fire Protection Association (NFPA)
   a. 1971 Standard for Protective Clothing (Coats and Trousers) for Structural Fire Fighting
   b. 1972 Standard for Structural Fire Fighter's Helmets
   c. 1973 Standard for Fire Fighter's Gloves
   d. 1974 Standard for Fire Fighter's Footware
   e. 1500 Standard Occupational Safety and Health
2. National Institute of Occupational Safety & Health (NIOSH)
   a. Certified
3. Occupational Safety & Health Administration (OSHA)
   a. Subpart
   b. Respiratory Protection
   c. Protective Clothing
4. Mine Safety & Health Administration (MSHA)
   a. 30CFR, Part II, Protective Clothing

In addition to the national standards, many areas have established state and local standards. For further information check with the state and local agencies.

STANDARD OPERATING PROCEDURES

To ensure the safety of rescuers as well as that of victims, each department should establish standard operating procedures for routine rescue evolutions. Using standard operating procedures provides each rescuer with preplanned techniques known by everyone on the rescue team. As each standard operating procedure is written, the need for protective clothing should be addressed. If a procedure mandates that specific clothing or equipment must be used during a rescue procedure, that policy must be strictly enforced. For example, it is standard policy that each rescuer must wear a self-contained breathing apparatus when entering a hazardous environment. No exception can be made to this standard operating procedure.

As a department purchases each piece of protective clothing the rescuers must become familiar with its proper care and use, either by carefully reading enclosed instructional materials or by attending in-service training sessions presented by manufacturers' representatives. One of the most important items is that a good seal is required between connecting pieces of clothing to ensure adequate protection for the rescuer. To help maintain the effectiveness of the sealing qualities of each item, the manufacturer's directions for use and care must be followed.

CHARACTERISTICS OF PROTECTIVE CLOTHING

Protective clothing is divided into the following three classifications:

Structural. Structural protective clothing includes a helmet, a coat, boots, trousers, a hood, gloves, and a self-contained breathing apparatus (see Figure 74).

Figure 74. Structural Protective Clothing

Specialized High-temperature. Specialized high-temperature protective clothing are as follows: fire entry, approach, and proximity. For specific details refer to NFPA and EPA guidelines.

Chemical. Chemical protective clothing is classified into two types: encapsulating and nonencapsulating (see Figure 75 and 76). For specific details see the hazardous materials chapter.

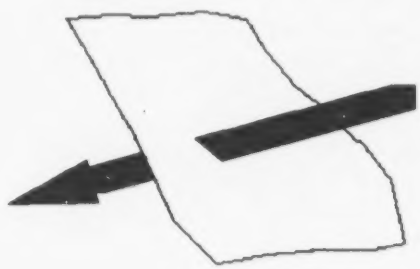
Figure 75. Encapsulating Suit

Figure 76. Nonencapsulating Suit

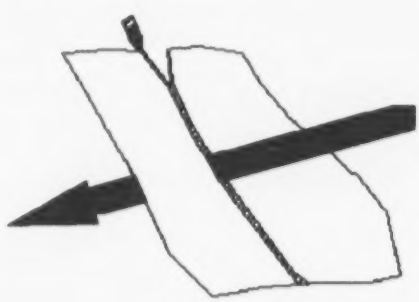
When selecting protective clothing to meet performance requirements, consider the following factors:

1. **Chemical resistance.** Protective clothing must maintain its structural integrity and protective qualities, and have the ability to withstand physical and chemical changes.
2. **Durability.** It is important for items to be made of a material that resists punctures, abrasions, and tears, and will withstand wear, since many rescue procedures involve situations where physical wear and tear occur.
3. **Flexibility.** It is important for rescuers to be able to move with ease while performing procedures.
4. **Temperature resistance.** The ability of materials to endure temperature extremes is important to the rescuer's safety.
5. **Size.** A good fit is important in protective clothing since it enhances the rescuers' ability to move, maneuver, and concentrate.
6. **Design.** The construction, material, and special features of each item of clothing should be evaluated to be sure department needs are met.
7. **Color.** It is advisable to select items that are a light color. Dark colors tend to absorb radiant heat from external sources and transfer it to the rescuer, and light colors reflect radiant heat make it easier to identify the personnel on the scene.
8. **Service life.** It is important that protective clothing resist deterioration and can be decontaminated effectively.
9. **Cost.** The cost of protective clothing will vary considerably with the capabilities and durability of each item. Each department must evaluate its budget and needs when deciding which items to purchase.

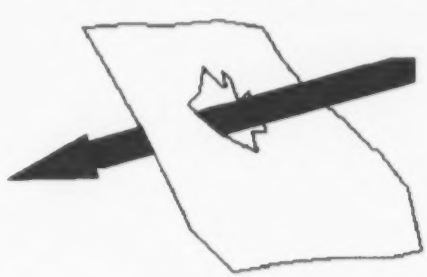
The effectiveness of protective clothing is based on its resistance to permeation, penetration, and degradation. **Permeation** is a chemical reaction involving the movement of chemicals through intact material. It is a process in which a chemical on the outside surface of the protective clothing is absorbed and diffused to the inside surface. The permeation rate is the rate at which a chemical will move through a given area in a given time. **Penetration** is the process of chemical transport through openings such as zippers, stitched seams, and flap closures. **Degradation** is the breakdown of the physical properties of the protective clothing due to exposure to a specific chemical or groups of chemicals, (see Figure 77).



Permeation is the movement of chemicals through intact protective clothing material.



Penetration is the passage of chemicals through holes that may be present from zippers, closures, seaming or other manufacturing steps.



Degredation is a breakdown in the physical properties of the clothing material due to the exposure to the chemical.

Figure 77. Permeation, Penetration and Degradation

CONCLUSION

Protective clothing must be utilized properly for rescuers to safely perform a rescue. No one type of clothing is available to protect the rescuer from all the hazards that can be encountered. During pre-planning rescue personnel should identify hazards that may occur in their local area and obtain the proper clothing and equipment needed to address those types of operations.